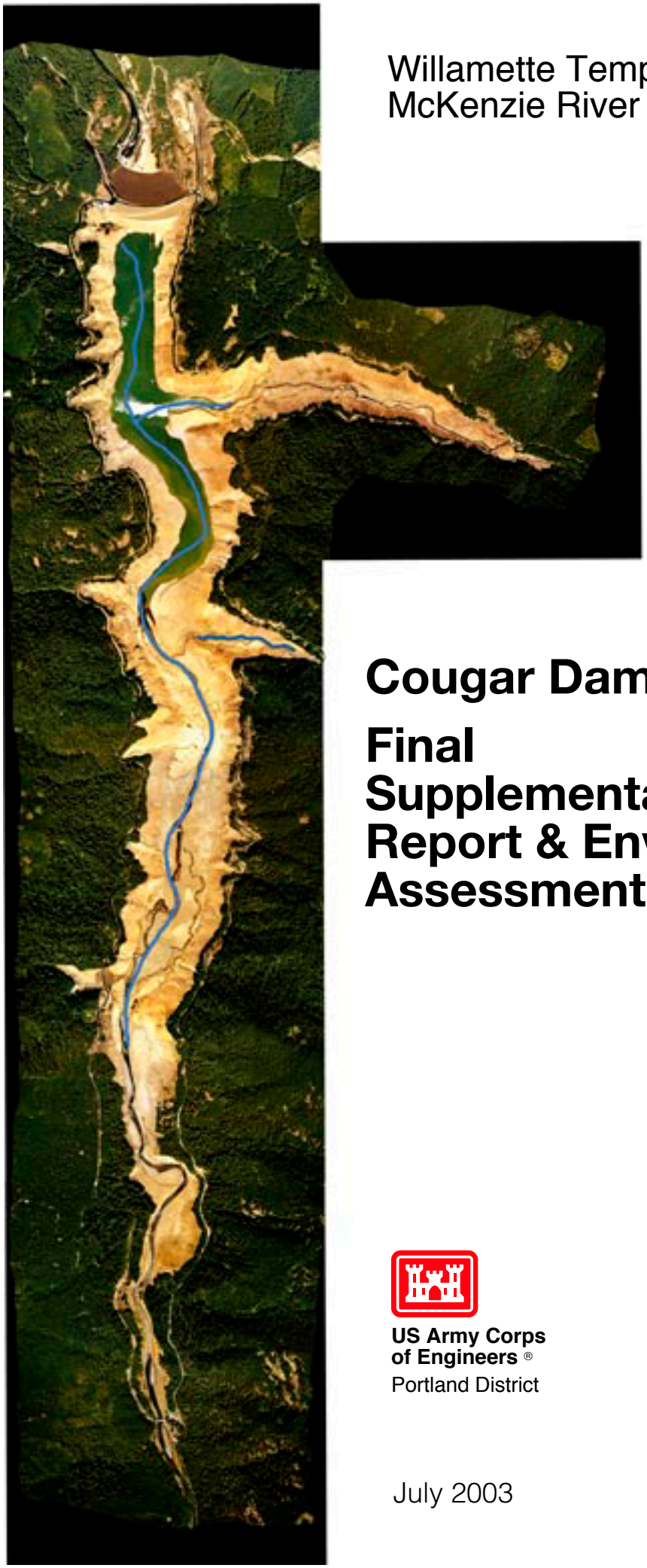


Willamette Temperature Control
McKenzie River Sub-Basin, Oregon

Cougar Dam and Reservoir

Final Supplemental Information Report & Environmental Assessment Amendment

US Army Corps
of Engineers ®
Portland District

July 2003

Cover photo: Aerial photograph of Cougar Reservoir with residual pool at 1,400 foot elevation. Fall 2002. Blue “river” is South Fork McKenzie channel location, pre-dam.

FINAL
SUPPLEMENTAL INFORMATION REPORT
WILLAMETTE TEMPERATURE CONTROL
MCKENZIE RIVER SUB-BASIN, OREGON
COUGAR DAM AND RESERVOIR

U.S. Army Corps of Engineers
Portland District

July 2003

FINAL
SUPPLEMENTAL INFORMATION REPORT
WILLAMETTE TEMPERATURE CONTROL
MCKENZIE RIVER SUB-BASIN, OREGON
COUGAR DAM AND RESERVOIR

TABLE OF CONTENTS

TABLES

FIGURES

APPENDICES

ENVIRONMENTAL ASSESSMENT AMENDMENT

blank

FINAL
SUPPLEMENTAL INFORMATION REPORT

WILLAMETTE TEMPERATURE CONTROL
MCKENZIE RIVER SUB-BASIN, OREGON
COUGAR DAM AND RESERVOIR

1.0 INTRODUCTION

Corps regulations for implementing NEPA, ER200-2-2,13(d), provides for publishing additional supplemental information documents on long-term or complex Environmental Impact Statements (EISs) to keep the public informed.

During the first year of project construction for Cougar Intake Tower Modification, drawdown of Cougar Reservoir resulted in unexpected turbidity below the dam in the South Fork McKenzie and McKenzie Rivers during Spring trout fly-fishing season. It was decided to prepare a supplemental information report (SIR) to address this turbidity and to investigate whether the turbidity had caused significant impacts to the river environment. Alternate methods of operating Cougar Reservoir during the remaining 2 years of construction also are being investigated. An amendment to the 1999 Environmental Assessment (EA) which supplemented the 1995 EIS, has also been prepared to address the turbidity, other new information, and the change in operation, based on data and analysis in this SIR.

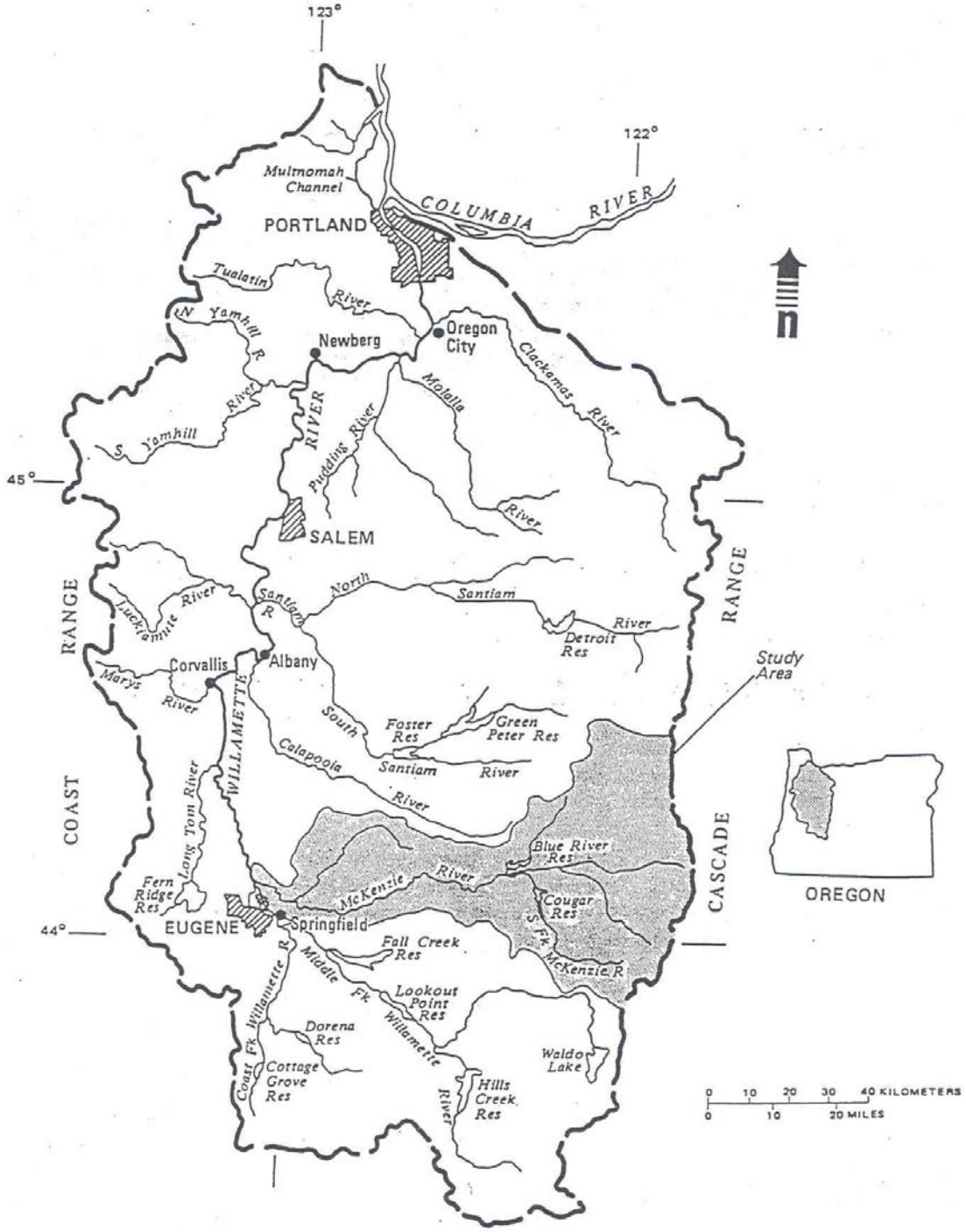
2.0 BACKGROUND

Cougar Project is an existing Federal reservoir project located in the watershed of the McKenzie River of western Oregon. (Figure 1) The McKenzie River originates in the upper elevations of the Cascade Mountains, flowing in a generally westerly direction to enter the Willamette River at River Mile (RM) 170.8 near Eugene. The Cougar Project provides flood control, recreation and power generation, and supplemental downstream flows for irrigation, navigation, fisheries, and pollution abatement.

A final Feasibility Report and Environmental Impact Statement (EIS) for Willamette Temperature Control was filed with the Environmental Protection Agency (EPA) in April 1995. The preferred alternative as described in the Record of Decision (ROD) signed January 9, 1997, was to construct intake structure modifications at both Blue River Lake and Cougar Lake. Construction at Cougar Lake was to begin in 1998, followed by Blue River Lake in 2002.

Following the ROD, design elements at Cougar Lake were further refined in Feature Design Memorandum (FDM) No. 21, published in July 1998. This refinement resulted in changes from the project description in the Feasibility Report. An environmental assessment (EA) and Finding of No Significant Impact (FONSI), signed in 1999, addressed changes in the proposed action at Cougar Lake since preparation of the final Feasibility Report/EIS.

Figure 1 -- *Willamette Basin Location Map*



2.1 Project Authorization. The Willamette River Temperature Control Project was authorized by the Water Resources Development Act (WRDA) of 1996 at a total Federal cost of $38,000,000. The authorization was based on the Feasibility Report dated April 1995. The authorization includes temperature control facilities at Cougar and Blue River projects, Oregon. In August of 1999, WRDA 1999 reauthorized the project at the cost presented in the 1998 FDM. Specific language was included related to cost growth of the project.

2.2 Construction. Construction of the Cougar portion of WTC began in August, 2001. The first phase involved strengthening and re-opening the diversion tunnel. The tunnel was reopened February 23, 2002, and drawdown of the reservoir began April 1. Reopening of the tunnel had been forecast for December 5, 2001 so that drawdown would begin February 1 and be completed to pool elevation 1,375 feet by April 1. Construction delays resulted in a later start than predicted. Phase 2 of the construction, modifications to the intake tower, began March 1, 2002.

2.3 Changes Since the Draft SIR. Since the draft SIR and Environmental Assessment amendment were released for public review on January 30, 2003, two relevant events occurred. One was a storm event in late January, following several other winter storm events. Storms occurred in late December 2002 which raised the reservoir elevation to 1,411 feet on December 31, 2002 and 1,413 feet on January 5, 2003. Turbidity on December 31 reached 202 NTUs. Turbidity levels rose again and reached 117 and 113 NTUs on January 3 and 5, 2003, respectively. Concurrent with the January 30 storm was a failure of the Rush Creek diversion outlet pipe. Following the initial elevated turbidity resulting from the failure, the pool was raised to 1,450 to cover the eroding slope below Rush Creek outlet. The slope failure caused an immediate spike in the turbidity downstream of the reservoir of 1,030 NTUs on January 30, 2003. The turbidity level dropped to 450 NTUs within 1 day and fell to 83 NTUs by February 3, 2003. While the slope failure caused an immediate spike, channel downcutting and migration by the South Fork McKenzie from January 30 to 31, 2003, resuspended a large amount of sediment contributing to the high turbidity observed downstream. (O'Brien, et al. 2003)

Once the situation stablized, turbidity returned to 2 NTUs by March 3, with occasional short-term increases due to rain or slope slump elsewhere in the reservoir. Based on surveys of the failed slope, the failure area is confined to overburden and has not impacted the toe of the dam. The Corps will continue to operate at 1,450 feet and monitor the slope to assess if any repairs are required. At this point, no repair action is planned.

Holding the reservoir at 1,400 feet during the winter did help regulate the turbidity until the January 30 storm when the Rush Creek outlet failed. Incoming turbidity in the South Fork during this January storm was about 78 NTUs. With the Rush Creek outlet failure, turbidity briefly (a one-half hour reading) exceeded 1,000 NTUs below the dam, and reached 100 NTUs on the mainstem McKenzie at Vida for a similar time period. As noted above, this cleared by early March. Turbidity during the March-April fly fishing season was, for the most part, near normal. In the March to May time period, incoming turbidity ranged from 30 to 0 NTUs; turbidity below the dam varied mostly between 25 and 2 NTUs, with one spike of 55 NTUs. Turbidity at Vida stayed between 15 and 1 NTUs with one spike of about 50 NTUs corresponding with the spike below the dam. Thus, managing the reservoir at elevation 1,450 during this period kept turbidity in the mainstem McKenzie within successful fishable limits. And, although the river was high, good insect hatches were reported (The Register-Guard, April 3, 2003). In addition, the coffer

dam was not breached, and construction continued all winter and spring seasons, keeping the project on schedule.

3.0 ENVIRONMENTAL COMPLIANCE TO DATE

3.1 National Environmental Policy Act Analysis. A draft Feasibility Report/Environmental Impact Statement (FR/EIS) on the Willamette River Temperature Control, McKenzie River Sub-Basin, was released for public review in December 1994. Two public hearings were held in 1995. The final FR/EIS was released in April 1995. The FR/EIS covered temperature control proposals for Cougar Reservoir and Blue River Reservoir. The Corps proceeded to develop temperature control for Cougar Reservoir, preparing a Design Memorandum (DM 21) in 1998. Changes from the FR/EIS were addressed in a draft Environmental Assessment, released for public review in July 1999, and a Finding of No Significant Impact was signed 30 November 1999. A draft SIR and EA amendment was prepared and released for review on January 30, 2003. Section 404 evaluations under the Clean Water Act were prepared for both EIS and EA. State water quality certification was not requested since the project is exempt under Section 404(r) of the Clean Water Act, which provides a mechanism where Congress permits discharges of dredge or fill material through specific Congressional authorization of a project.

3.2. Clean Water Act Analysis. The Oregon Department of Environmental Quality reviewed both the 1995 EIS and the 1999 EA/Section 404 Evaluations. ODEQ's comments in 1999 were that the potential of the project to produce long-term, identifiable benefits to the fisheries resource through temperature modification appeared to outweigh any short-term effects of turbidity. Should turbidity during construction be visible in the McKenzie River, the reason must be determined and BMPs implemented to solve the problem and minimize the impacts. A log of storm events and river conditions should be maintained and problem events reported to ODEQ. These requirements have been followed by the Corps.

Turbidity refers to water clarity. It is measured in Nephelometric Turbidity Units (NTUs), which indicate how light passes through (or reflects on) suspended sediment in the water column. State standards for turbidity (OAR 340-041-0445(2)(c)) are no more than a 10 percent cumulative increase in natural stream turbidities as measured relative to a control point immediately upstream of the turbidity causing disturbance. However, limited duration activities necessary to accommodate essential dredging, construction or other legitimate activities may be authorized provided all practicable turbidity control techniques have been applied and permit or certification authorized under terms of Section 401 or 404 of the Clean Water Act.

3.3 Biological Assessment/Biological Opinion . A biological assessment (BA) for the Willamette Temperature Control project (Cougar and Blue River) was prepared in September 1994. The BA for Cougar was amended in October 1999, and a Biological Opinion (BO) was issued jointly by USFWS and NMFS on March 8, 2000.

4.0 DESCRIPTION OF THE ACTION TO DATE

4.1 Diversion Tunnel Construction. Activities to re-open the main diversion tunnel began in August 2001. The tunnel was lined with concrete, and gates to control flow were installed. The

plug installed after completion of Cougar Dam was removed in stages. Construction runoff water was diverted into settling ponds prior to release into the South Fork McKenzie River.

4.2 Tunnel Tap. The final stage in opening the diversion tunnel was the "tap" which occurred on February 23, 2002. As the last of the concrete plug was blasted out, a torrent of 3,500 cfs of water from the bottom of the reservoir flowed out of the tunnel and down the South Fork McKenzie for about 45 minutes. The tap was observed by Corps staff and representatives from ODEQ, ODFW, NMFS as well as the press. The tunnel gates were closed for tunnel inspection, then reopened to prepare for drawdown at a slower rate.

4.3 Drawdown. Once the diversion tunnel was open, reservoir drawdown began at a rate of 3 feet per day. This was the maximum drawdown rate geotechnical staff believed was safe to avoid slumpage and possible damage to the dam (See FDM). A major rainstorm that produced approximately 3 inches of precipitation in the watershed above Cougar Reservoir over a 24-hour period occurred on April 13, 2002, delayed completion of reservoir drawdown. Drawdown was halted on May 26, 2002, at elevation 1,400 feet (instead of 1,375 feet as originally planned) due to the occurrence of unexpectedly high turbidity levels during drawdown. Stopping the drawdown process early was implemented to reduce river turbidity levels. Water cleared to less than 15 NTUs within 20 days. Termination of drawdown at 1,400 feet slightly increased the risk of flooding the construction area during the construction period.

4.4 Intake Tower Construction. Construction of the temperature control modifications to the existing intake tower is expected to take 3 years. Actions to date have included 1) diverting Rush Creek from the intake tower construction area; 2) foundation preparation work, to include rock blasting, excavation, and hauling of excavation material; 3) construction of a concrete cofferdam to protect the intake tower construction area from flooding; and 4) demolition of the fish horns, trash structure, and trash structure access bridge.

4.5 Environmental Coordination Committee (ECC) Meetings. In keeping with the commitment made in the FR/EIS, an Environmental Coordination Taskforce was established as a committee. The ECC is composed of staff from various Federal and State agencies, the McKenzie Watershed Council and Eugene Water and Electric Board (EWEB). The ECC has met quarterly, or more often if necessary, throughout final design and construction work. Most meetings are on site at the Cougar Project.

4.6 Water Quality and Sediment Monitoring. Construction activities and changes in the way the project is operated could impact water quality in the reservoir and in the river below the reservoir. To meet Corps policy, and the Clean Water Act, monitoring of water quality at project during construction was necessary. In consultation with the resource agencies, the Corps developed a water quality monitoring program that was implemented the year before construction began. The monitoring will continue for the 3 years of construction and during 1 year post construction. Monitoring sites were set up above and below the reservoir at the USGS gage stations and at three sites on the reservoir.

The Corps contracted with the United States Geological Survey (USGS) to re-establish the upstream monitoring gage (gage 14159200) and re-furbish the downstream gage (gage

14159500) on the South Fork McKenzie. The upstream gage measures water elevation (discharge is calculated), temperature and turbidity; the downstream gage measures water elevation (discharge is calculated), temperature, turbidity, dissolved oxygen (DO) and DO percent saturation. These gages have been in place since November and December of 2000 and operate continuously, reporting measured parameters as an average over every half-hour. The turbidity gages are sensitive to anything that reduces light, such as chemicals, sediment and organic particles, algae and, occasionally, insects or debris that can block the path of light. Unusually high turbidity readings may also result from fouling of the instrument, so it requires frequent maintenance. Three additional monitoring gages were established in 2003. One is on the McKenzie above the confluence with the South Fork; one is on the McKenzie at Vida ; and one is on Blue River below Blue River Dam. USGS maintains a website for data collected at these gages at http://oregon.usgs.gov/mckenzie/monitors.

The Corps contracted with the USFS, Blue River Ranger District, to monitor water quality in the reservoir before and during construction of the selective withdrawal project. The USFS collects data from April through November at three sites on the lake – near the withdrawal tunnel, the East Fork arm and the South Fork arm. In 2000 and 2001 the reservoir was sampled monthly, and in 2002 bimonthly. A Hydrolab instrument is used to profile the reservoir from surface to bottom at the three sites. Parameters measured are depth, temperature, dissolved oxygen, dissolved oxygen percent saturation, pH, specific conductivity and turbidity.

To assess whether the turbid water from drawdown contained contaminants associated with sediment, the Corps contracted with the USFS to collect water samples for analysis. During drawdown of the reservoir to construction pool elevation, the USFS collected water grab samples for chemical analysis from the South Fork at the gage sites above and below the reservoir (one and four samples, respectively), and in the mainstem McKenzie River at Hayden Bridge (three samples).

The water samples were collected on three dates: May 15, June 3, and June 17, 2002. These were sent to Severn Trent Laboratories (STL) for analysis of contaminants including 17 metals, 18 polynuclear aromatic hydrocarbons (PAHs), 26 organophosphorus pesticides, 12 chlorinated herbicides, 20 organochlorine pesticides, 5 anions, total organic carbon (TOC), biological oxygen demand (BOD), color, conductivity, cyanide, fecal coliforms, hardness, total dissolved solids (TDS), and turbidity.

To determine the physical nature of the turbid water and the potential for siltation downstream of the dam, the Corps asked the USFS to collect water samples at the above sites for analysis of Total Suspended Solids (TSS) and grain size distribution. Analyses of the samples were carried out by the USGS Volcano Observatory Lab in Vancouver, Washington. Samples were collected according to the schedule in Table 1 below.

During August, an algae bloom developed in the reservoir. This is a typical annual event but because of the smaller size of the pool and the visual appearance of the bloom the Corps had the USFS collect water samples for species identification and cell density determinations. These analyses were performed by Mr. Jim Sweet of Aquatic Analysts.

Table 1 Water Quality Samples

Sample #	Site Description	Date-time	Turbidity (NTUs)
CUGRUS	gage 14159200 US of res	5/15/02-1400	0.5
CUGRDS1	gage 14159500 DS of dam	4/24/02-0745	32.0
CUGRDS1d	gage 14159500 DS of dam	4/24/02-0925	31.8
CUGRDS2	gage 14159500 DS of dam	5/2/02 -1500	95.8
CUGRDS3	gage 14159500 DS of dam	5/15/02-1510	86.0
CUGRDS4	gage 14159500 DS of dam	6/3/02 -0825	42.0
CUGRHB	M. R. at Hayden Br	5/15/02-1745	-
CUGRHB2	M. R. at Hayden Br	6/3/02 -0645	-

The results of the water quality monitoring effort, before and after drawdown, are summarized below and presented in more detail in Appendix A of this report.

4.6.1 Pre-drawdown water quality**.** The monitoring data from year 2001, before construction began, showed that water quality in the reservoir and in the South Fork above and below the reservoir is excellent, although temperature is sometimes higher than desired for salmonids. State Standards for temperature, DO, and pH are not violated; nutrients concentrations are low (See Hains, April 2000). At the upstream site, water temperatures did not exceed 60°F and turbidity was usually less than 5 NTUs with occasional spikes up to 324 NTUs during storm events. At the below dam site water temperatures never exceeded 60°F, turbidity rarely exceeded 50 NTUs and usually was below 10 NTUs, and daily minimum oxygen ranged between 7.4 and 11.6 mg/L. In August, during the warmest period in the reservoir, oxygen ranged from 8 to 15 mg/L, temperatures varied from 73°F at the surface to 47°F at the withdrawal outlet. These data support conclusions from earlier studies that indicate that Cougar Reservoir is somewhere between having a moderate amount of nutrients (mesotrophic) and very low nutrients (oligotrophic) and that the South Fork McKenzie river has excellent water quality with some temperature limitations.

4.6.2 Drawdown water quality - turbidity**.** Because of tunnel construction delays, drawdown of the pool was delayed and began on April 1 continuing to May 26, 2002. The results of turbidity monitoring below the dam at the gage station are shown in the graph below (Figure 2). At the gage about 0.5 miles downstream of the dam turbidity ranged from 1 to 379 NTUs. Median turbidity levels were 98 NTUs with the high of 379 NTUs occurring on April 28.

A factor that exacerbated the turbidity coming out of the lake was a storm event in the watershed above the project that caused inflows to increase up to 5,800 cfs on April 14, 2002 (Figure 3). This inflowing water was highly turbid and ran up to 327 NTUs at 05:00 AM. At this time, turbidity below the dam was 48.4 NTUs. Beginning mid-morning of the 14th, turbidity started to rise below the dam. At about 23:00 hours of the 14th turbidity increased to 135 NTUs. There was

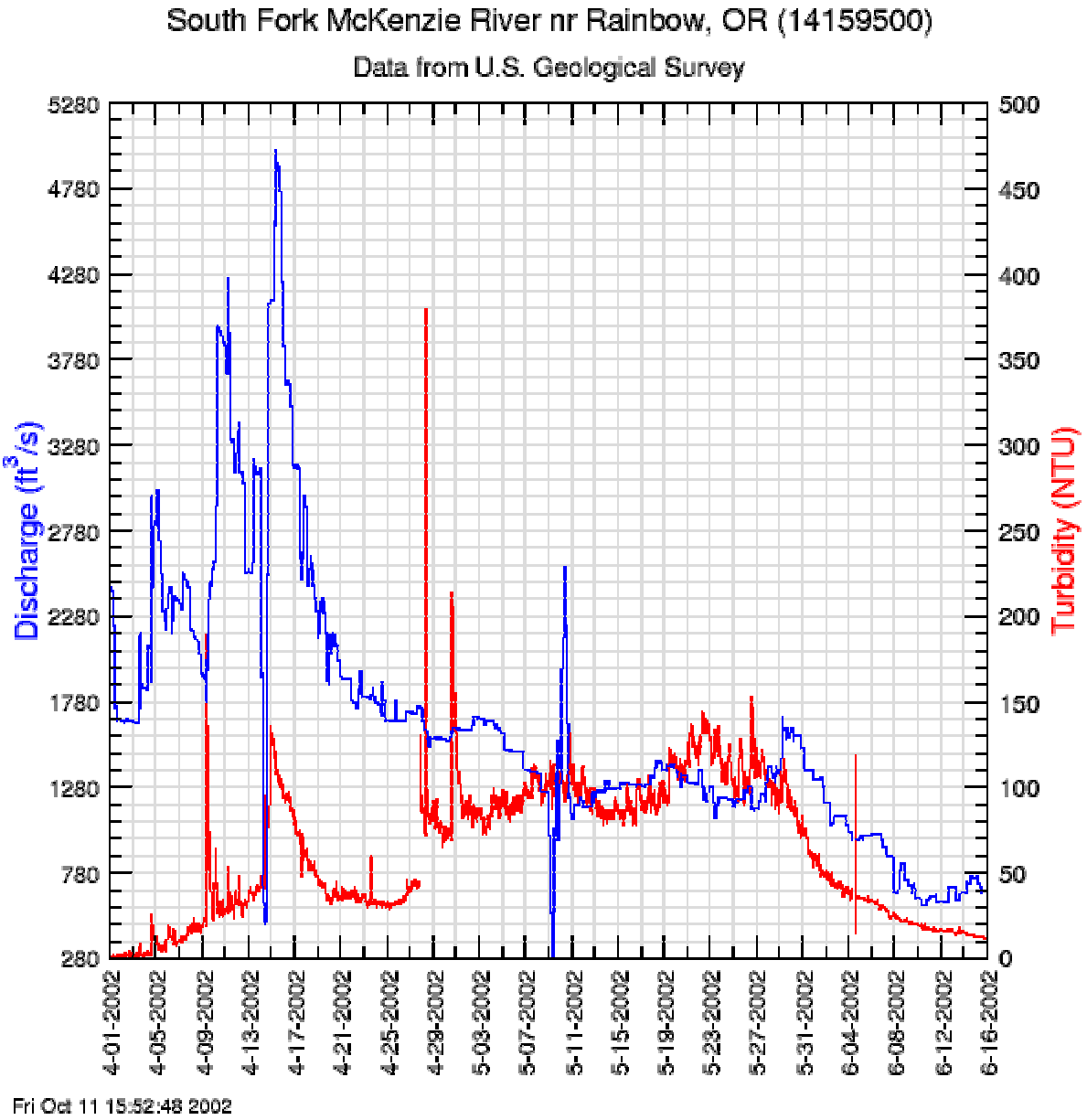


Figure 2. Discharge and turbidity at gage 0.5 miles downstream of dam during drawdown of 2002.

an 18 hour spread between the peak turbidity at the gage upstream of the reservoir and the peak turbidity downstream of the reservoir. After that, turbidity below the dam dropped gradually to around 30 NTUs 11 days later on April 25. If no dam had been in place during the early April storm event, we could have expected turbidity levels to have reached 300 plus NTUs in the mainstem McKenzie where the South Fork enters it. Prior to the dam, high turbidity events like this would have cleared quickly from the McKenzie system. Over the last 40 years one of the impacts of the dam has been to dampen these high turbidity events. The dam causes turbidity downstream from these events to be lower and spread over a longer period.

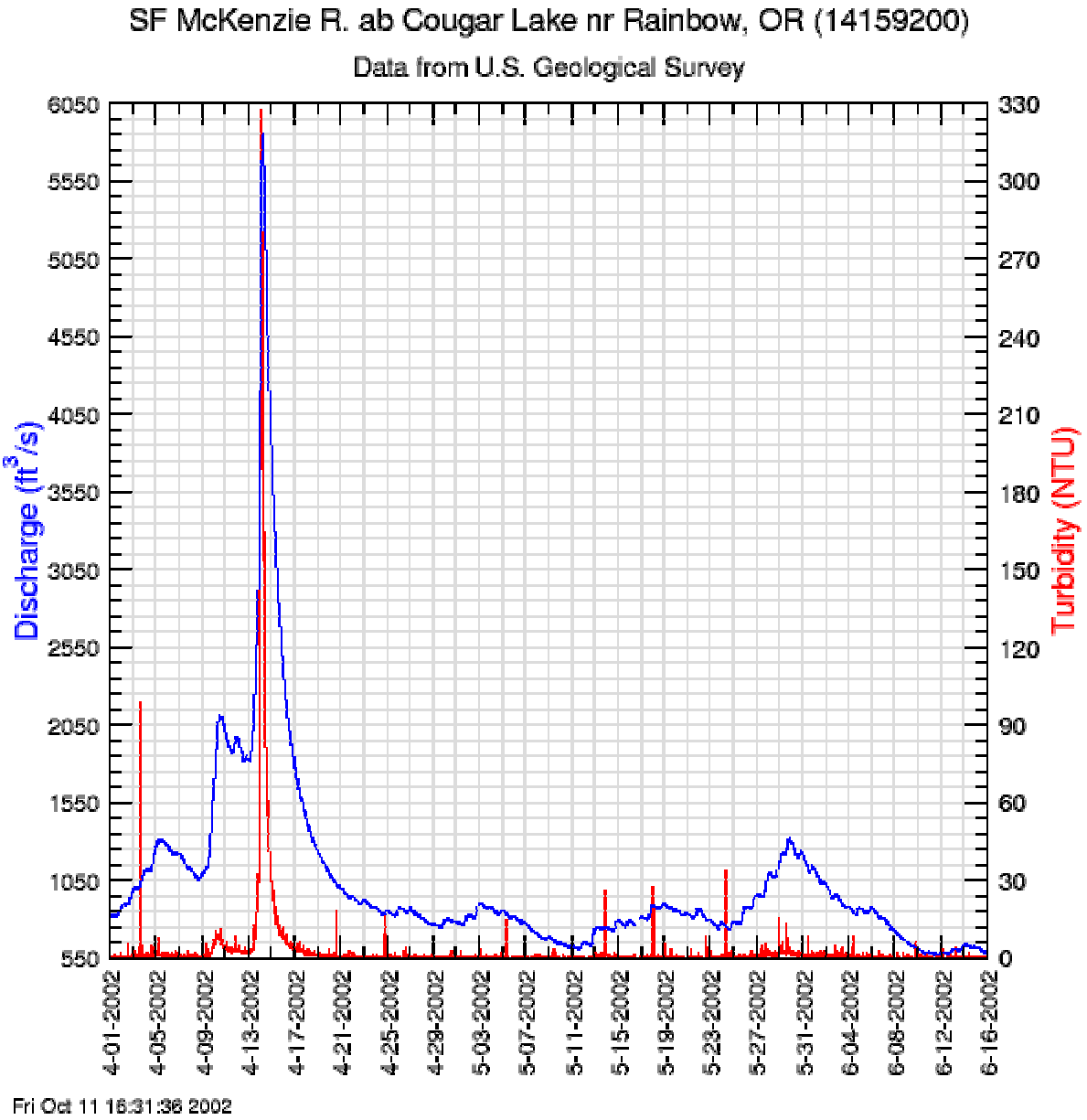


Figure 3. Discharge and turbidity during drawdown at the gage upstream of the dam.

Beginning on April 25 turbidity below the dam gradually rose to around 150 NTUs by the 26th of May. Over this period turbidity averaged around 100 NTUs. From the 26th of May to mid June there was a rapid drop in turbidity to less than 10 NTUs. Following the early April storm event it took about 6 weeks for the reservoir to clear up as drawdown proceeded.

For the duration of drawdown, higher than normal turbidity for this time of year was observed in the South Fork below the dam and in the mainstem McKenzie at least as far as Hayden Bridge near Springfield.

4.6.3 Drawdown water quality – other parameters. During drawdown, median DO in the South Fork McKenzie was 11.33 mg/L and median percent DO saturation was 98.8 percent. Neither violated State standards. Maximum temperature achieved was 49.6°F.

As stated earlier, samples were taken of the water coming into the reservoir and of the turbid drawdown water for analysis of metals, PAHs, organophosphorus pesticides, chlorinated herbicides, organochlorine pesticides, conventionals, Total Suspended Solids (TSS), and grain size distribution. A total of eight samples were taken between mid May and mid June of 2002 during a range of turbidities. No contaminants were detected above established EPA concern levels (EPA, 1986) in any sample. In one drawdown sample, CUGRDS1, taken at the gage below the dam when turbidity was 86 NTUs, 0.454 ug/L of diazinon and 0.155 ug/L of malathion were detected but not in a duplicate sample from the same site. A trace of DDT was detected in this sample at 0.000599 ug/L, which was also not confirmed in the duplicate sample. This DDT level is below the EPA freshwater acute (1.1 ug/L) and chronic (0.001 ug/L) water quality criteria for DDT. The lack of detection of malathion and DDT in the duplicate sample lends credence to the view that, if the chemicals were in the sample, they were there in very low concentrations.

Since there were no contaminants in concentrations above EPA concern levels in the eight samples, it appears that export of contaminants from the reservoir was minimal. Because DDT was found in reservoir sediment samples, more downstream samples will be taken in 2003 to determine whether DDT is being exported from the reservoir.

The organochlorinated pesticide beta-BHC was detected at 0.000562 ug/L in a sample taken of inflow water to the reservoir. This was also well below the acute water quality criterion of 100 ug/L for BHC.

The physical nature of the material in the turbid water released from the reservoir during drawdown was investigated. Table 2 below shows characteristics of sediment in drawdown water samples. Sediment in the drawdown samples was very fine-grained, with concentrations (21 to 85 mg/L, see Appendix A). For the seven samples an average of 92 percent of the material in the water was finer than the 62 micron (.062 millimeters) grain size that separates silt and clay from sand.

It was difficult to get enough sediment out of a sample for grain size distribution analysis. A hydrometer analysis done on a sample taken on May 15, 2002, at the gage downstream from the dam, when turbidity was at 86 NTUs, revealed that 99 percent of the sediment was smaller than 62 microns and 74 percent of that was in the clay size – 4 microns or smaller (31 percent was smaller than 1 micron; See Appendix A).

A bloom of blue-green algae usually occurs in Cougar Reservoir in August. This again happened in August of 2002. A total of 18 species were identified in the algae bloom. The bloom was dominated by the blue-green species *Anabaena flos-aquae* and *Anabaena circinalis*. Cell densities for *flos-aquae* varied from 9,160 cells/ml on August 7 to 139,066 cells/ml on August 19. The State of Oregon has not established an official standard for Anabaena cell densities.

Table 2 Grain size characteristics of sediment in drawdown outflow water samples taken below Cougar Dam and at Hayden Bridge

sample location	date	time	gage NTU	mg/L	sediment total	sediment sand mg/L	sediment fines	% finer than 62 microns
USGS gage above reservoir (CUGRUS)								
	5/15/2002	14:00	0.5	1.0	1.0	0.4	0.6	59
USGS gage below reservoir (CUGRDS)								
	4/24/2002	7:45	32.0	60.0	60.4	0.6	59.9	99
	4/24/2002	9:25	31.8	21.0	21.1	0.4	20.7	98
	5/8/2002	15:00	96.8	85.0	85.3	2.2	83.0	97
	5/15/2002	15:10	86.4	39.0	38.6	0.5	38.0	99
	6/3/2002	8:25	42.2	26.0	25.8	0.2	25.6	99
Hayden Bridge (CUGRHB)								
	5/15/2002	17:45	11.4	12.0	11.7	0.1	11.7	100
	6/3/2002	6:45	6.0	8.0	8.1	0.7	7.4	92

However, recently, the State Health Department has recommended posting lakes where the cell density exceeds 15,000 cells/ml as recently happened at Diamond Lake and Hills Creek Reservoir.

4.6.4 Summary**.** Water quality was monitored above, in, and below the reservoir prior to, during, and after the tunnel tap and drawdown. Water quality in the South Fork and reservoir prior to the beginning of construction was very good. Temperature and oxygen levels met State standards. Construction activities and drawdown impacted water quality by increasing turbidity to high levels (median 98 NTUs during drawdown) below the dam. Other water quality parameters of concern, such as metals and pesticides, were below established concern levels - except for the possibility of a slight detection of DDT in one downstream sample that was not confirmed in a

duplicate sample. The high downstream turbidity and detection of DDT in exposed reservoir sediment raised questions regarding the potential for export of sediment and DDT downstream of the project. Future studies will address these concerns. Although previous sampling of reservoir sediments found no DDT, this pesticide was sprayed throughout the watershed prior to its being banned in 1972, and still remains in surrounding forests. (See Appendix B.)

4.7 Fisheries Monitoring. The Corps' BA recognized that potential problems associated with implementation of the Cougar WTC project might impact fish and wildlife resources. As a result, a multi-faceted monitoring plan was developed and implemented. This plan included biological monitoring of fisheries resources.

The Corps has an Intergovernmental Agreement with ODFW to provide assistance to the Corps in developing and implementing the monitoring plan. Actions under the plan included 1) collection of bull trout life history information prior to initiation of, and concurrent with, construction activities; 2) monitoring distribution, abundance and behavior of bull trout within and above the Cougar residual pool during construction; 3) monitoring for potential stranding, and rescue, of fish during drawdown of Cougar Reservoir; 4) monitoring distribution, behavior and condition of fishes below Cougar Dam before and during construction; 5) transport of spring chinook salmon and bull trout to above the residual pool during construction; and 6) development (and potential implementation) of a rescue plan for bull trout as an alternative to continuing use of the residual pool as a sanctuary area. Following the high turbidity events during Spring 2002, the Corps also collected data regarding structure and integrity of aquatic macroinvertebrate communities and habitat above and below Cougar Reservoir in the South Fork McKenzie River and in the mainstem McKenzie River.

Prior to drawdown of Cougar Reservoir, the Corps initiated studies regarding the behavior and distribution of bull trout above Cougar Dam. From these studies, ODFW has provided information to the Corps and to the ECC that has been helpful in evaluating project management options and in avoiding impacts to this species. These studies will continue throughout the construction phase of the Cougar WTC project and for 1 year following construction. Details of these studies can be found in the BO.

Prior to the bypass tunnel tap on February 23, 2002, ODFW placed live cages containing hatchery rainbow trout in strategic locations below Cougar Dam in order to monitor the effects of turbidity and other water quality conditions during the tap. ODFW also floated the river prior to, and following, the tunnel tap.

ODFW monitored conditions in the residual pool and below Cougar Dam during, and following, the drawdown of Cougar Reservoir. Drawdown was initiated on April 1st and completed on May 26th. ODFW has continually monitored the residual pool above Cougar Dam and the South Fork McKenzie River downstream of Cougar Dam for potential impacts of construction activities on bull trout, spring chinook salmon or other fish species. During and following drawdown, ODFW collected and assessed the health of wild fishes from several sites in the McKenzie River Basin. Results of these monitoring efforts are reported in quarterly monitoring and annual progress reports. If unusual mortality (e.g., other than normal post-spawning mortality) to spring chinook salmon, bull trout or other fish species is observed, NMFS, USFWS and ODFW are advised by

the Corps; an attempt to determine causative factors is initiated; and the results of the investigation are documented. If causative factors are associated with Cougar WTC project activities, the Corps or the Corps's contractor implements BMPs and takes whatever immediate corrective action is necessary and appropriate to resolve the situation. The Corps consults with and advises NMFS, USFWS and the ECC, accordingly.

4.8 Spotted Owl Monitoring. A pair of northern spotted owls nest near Rush Creek and Cougar Reservoir intake structures. The Biological Opinion (BO) issued on March 8, 2000, requires noise monitoring for the Federally listed threatened northern spotted owl, and specifies that noise levels must not exceed 60 dBA (leq) during construction and must not exceed 90 dBC (peak) during blasting. Monitoring is required when construction occurs during the nesting season, from February through August.

To not disturb owls, a noise monitoring station was established to determine noise levels during construction. Minor construction activities were conducted during early February of 2001 and no blasting occurred during this time. Construction activities consisted of off-loading dive equipment from barges onto trucks and movement of trucks. Monitoring was conducted during 1-hour periods selected during noisier times of construction on February 1, 2, and 6. Average noise levels were noted on a minutely basis during each of the three 1-hour monitoring periods and dBA (leq) were below 60 for each minutely record for each of the 3 days of construction. Therefore, construction activities complied with noise requirements identified in the BO. Noise is monitored by Corps Operations staff and contractors, and reported to District Office wildlife biologists.

Monitoring of nesting activities of spotted owls was conducted by Dr. Steven Ackers of H.J. Andrews Experimental Forest. Two young were produced during 2001 and both were banded. The Rush Creek pair did not nest in 2002. The previous male was replaced by a new male that was originally banded as a juvenile more than 8 miles to the north in 1996. The female was the same one that has been there for 9 years (this was the 10th year). The pair did nest in 2003 and fledged two young.

Blasting during 2002 occurred during September after the nesting season, and therefore did not require monitoring per the BO.

4.9 BMPs Implemented. Best Management Practices (BMPs) are defined by EPA as permit conditions used in place of or in conjunction with effluent limitations to prevent or control the discharge of pollutants. They may include schedule of activities, prohibition of practices, maintenance procedure, or other management practice. BMPs may include, but are not limited to, treatment requirements, operating procedures, or practices to control plant site runoff, spillage, leaks, sludge or waste disposal, or drainage from raw material storage. The Corps implemented BMPs appropriate for construction within a reservoir relative to Section 402 of the Clean Water Act. As conditions changed, the Corps added BMPs when feasible. For example, when a temporary bridge was constructed across the South Fork McKenzie, rounded river rock from within the McKenzie River Basin, instead of commercial gravel, was used to support five large culverts. When the culvert bridge was removed, the river gravel remained to replenish natural spawning gravel supplies in the river. When turbidity from the drawdown was perceived

as a problem, drawdown was halted at elevation 1,400 feet, reducing the drawdown period by 9 days. Although this increased the risk of storm-caused flooding of the intake construction area, it was implemented as a BMP to reduce the period of turbidity.

4.10 Public Information Meeting. On May 22, 2002, the Corps held a public information meeting at Walterville, Oregon, to discuss issues, especially turbidity, resulting from construction at Cougar. About 300 people attended and were provided an opportunity to express opinions and ask questions. The Corps set up a website (https://www.nwp.usace.army.mil/issues/wrtcp/) to address results of the meeting. Identified concerns were described and responded to within the web site.

4.11 Public Review Meeting. The Corps held a public meeting on February 12, 2003, at Walterville, Oregon, to discuss the findings of the SIR, accept public comment on the SIR and EA amendment, and to explain the events of January 30 when the Rush Creek outlet failed. About 80 people attended.

5.0 PROPOSED MANAGEMENT OPTIONS FOR REMAINING CONSTRUCTION

The options available for reducing the high spring turbidity associated with drawdown are 1)increasing the drawdown rate below pool elevation 1,532 feet, 2) adjusting the winter flood control pool elevation, and 3) adjusting the target date to reach construction pool of 1,400 feet. Due to the Rush Creek outlet failure, another option, maintaining the winter flood control pool and the construction pool at 1,450 has been added.

5.1 Discussion and Evaluation of Options. The range of options available for reducing the high spring turbidity were combined into six alternative operational plans. A target date of March 1 for drawdown to 1,400 is desired, as it gives a month to flush out any residual turbidity in the lower pool. Table 3 summarizes the alternative plans studied.

Table 3 - Cougar SIR Operational Alternative Plans*

Alternative	Target date	Drawdown rate	Winter Pool Elev.
LP1	-	3 ft/day	1400 ft
LP2	-	6 ft/day	1400 ft
HP1	March 1	3 ft/day	1532 ft
HP2	April 1	3 ft/day	1532 ft
HP3	March 1	6 ft/day	1532 ft
HP4	April 1	6 ft/day	1532 ft

*Maintaining the pool at 1,450 feet was not analyzed as an alternative.

Advantages and disadvantages for maintaining the pool this winter at or near elevation 1,400 feet are listed below.

Advantages:

- Widening and armoring of existing channel feeding lower reservoir pool due to winter flows, reduced risk of old channel abandonment/new channel formation.
- Higher probability of reaching elevation 1,400 by March 1 if there is a high-water event during the winter. This is because of the lower residual pool elevation prior to the high-water event (i.e., there is a higher probability of having a lower pool elevation after storing a flood).
- During the winter, a shorter timeframe for flushing turbid water from the residual pool because of the lower volume and detention time.
- Vegetation established below 1,532 feet during summer 2002 would not be drowned out, and become better established. This would reduce erosion in the lower pool, thereby reducing sources of turbidity within the reservoir. Turbidity in succeeding years would be reduced as a result.

Disadvantages:

- Higher turbidity during the winter. Increased number of turbidity events and increased turbidity associated with each event. Rapid rises in the pool level during winter storms will result in erosion of exposed sediments surrounding the residual pool.
- Higher and more variable flows downstream of the reservoir during the winter.

Advantages and disadvantages for filling the reservoir to elevation 1,532, then drawing it back down again in mid-January are listed below.

Advantages:

- Reduced probability of turbid flows below the dam during the winter if the reservoir fills with clear water, or following clearing of turbidity from the reservoir after it fills.
- Reduced or more normal winter turbidity downstream of Cougar reservoir during the filling period.

Disadvantages:

- Increase in risk that a new channel could be formed during the next drawdown to 1,400 feet. The new channel would cut through erodable material in the mid pool area transporting more material to the lower reservoir pool, increasing turbidity of the pool overall.
- Higher risk of increased turbidity below the dam during the spring as sediment re-distributed and deposited in the reservoir channel during inundation is re-suspended during drawdown.
- Lower probability of reaching el. 1,400 by March 1 if there is a mid-January or mid-February high-water event. A high-water event in mid-January or mid-February would impact the timing and duration of drawdown increasing the chance of turbid flows in the spring.
- Longer timeframe for flushing turbid water from the reservoir over winter because of the larger volume and longer detention time. However, turbidity would not peak as high.

In order to assess the potential effects of the six proposed operational plans on the McKenzie River system and Blue River Reservoir, system analysis was performed using HEC ResSim, a computer model capable evaluating the proposed operational criteria. Appendix C contains a technical summary of the modeling and results.

The results of the modeling determined the probability of reaching the target construction pool on March 1 under the six alternatives. Table 4 summarizes the results.

The two alternatives with the best chance of reaching a pool elevation of 1,400 feet are HP3 and LP2. In HP3, when the reservoir pool is raised to elevation 1,532 feet, it would only be

Table 4 Cougar Pool Elevations (ft), 10-90 Percent Non-Exceedance Probabilities at March 1*

	10 %	25%	50%	75%	90%
HP1	1404	1405	1412	1443	1483
HP2	1454	1456	1457	1460	1488
HP3	1401	1403	1406	1412	1455
HP4	1454	1456	1459	1461	1472
LP1	1400	1401	1404	1435	1464
LP2	1396	1400	1403	1407	1447

*Maintaining the pool at 1,450 feet was not analyzed as an alternative.

maintained at that elevation for about 6 weeks. As such, most of the benefits of keeping the reservoir pool at elevation 1,532 feet may not be realized. In addition, the difference between the two alternatives is only significant for an average or below average water year. An above average water year does not significantly favor either alternative. Given the number of advantages for maintaining the reservoir pool at or near elevation 1,400 feet, the preferred operational alternative is to keep the pool at or near elevation 1,400 feet for the duration of the construction project using a drawdown rate of 6 feet/day below elevation 1,532 feet (LP2).

5.2 Preferred Option for 2003/2004 Due to the Rush Creek outlet failure, the preferred alternative for operation of Cougar Reservoir during the winter and spring of 2003 and 2004 is a modified low pool/6 feet/day drawdown option. The Corps will attempt, as much as possible, to maintain the pool at elevation 1,450 feet during the winter. When the pool exceeds 1,450 feet, then drawdown will be at the 6 feet/day rate. If the winter is wet, or if heavy rain occurs during the late winter/early spring, the pool elevation will be above 1,450 feet for short periods.

With the pool maintained at this higher elevation the following could occur:

- An increased risk of flooding the construction site by overtopping the cofferdam at 1,495 feet during the construction season (13.7 percent vs. 7.8 percent).
- An increase in the relative time it takes to clear the reservoir of turbid water caused by erosion occurring within the reservoir. The volume of water the reservoir holds at 1,450 feet is approximately three times greater than at 1,400 feet. It would take longer to clear the reservoir of the turbid water, extending the duration of the turbidity downstream.

The effects on erosion and sedimentation processes within the reservoir by operation of the pool at the 1,450 foot level versus 1,400 feet are:

- A likely decrease in slope failures in the lower pool. Several localized slope failures were observed after the late January storm. Changes in pool elevation would be smaller for a 1,450 foot pool given the higher storage capacity above 1,450 feet.
- More of the exposed fine sediment deposits are covered at a 1,450 foot level, thereby exposing less material to resuspension and transport downstream. (O'Brien, et al. 2003)

5.2.1 BMPs for Subsequent Drawdowns. Based on present information, the adopted operation for 2003 will be maintained. The 2003 operation will be closely monitored. The operation will be further modified if needed.

5.2.2 BMPs After Drawdown. After drawdown is complete each year, beginning on or after March 1, BMPs to reduce turbidity will be evaluated. These include improvements to the upstream channel and operational changes to managing the reservoir.

5.2.3 Operation of Blue River Reservoir. Operations at Blue River reservoir will be essentially unchanged due to construction activities at Cougar. During the spring and winter, Blue River reservoir will be operated for flood control. Releases will be closely coordinated with outflows from Cougar reservoir. During the summer months, flows from Blue River may be used to dilute turbidity spikes in the mainstem McKenzie River that result from storm events at Cougar Reservoir.

6.0 DESCRIPTION OF ACTIONS TO BE COMPLETED

Construction of the Cougar intake tower modification is proceeding. Actions completed included slope reinforcement, diversion of Rush Creek, demolition of selected tower features, excavation of the tower foundation area, and construction of the cofferdam, which will help to protect the work site from flood events that may occur over following construction seasons. The tower modification is 30 percent completed as of late Spring 2003. Construction remaining to be completed includes final modification of the intake tower. This activity will require maintenance of Cougar Reservoir at the residual pool elevation of 1,450 feet during construction periods in 2003 and 2004.

The in-water part of a temporary fish trap below the dam has been constructed. Construction of the upland part of the trap has been suspended due to cost and operational changes since the BiOp (Reasonable and Prudent Measure 5) requiring the trap be constructed. Specifically, the residual pool was drawn down to elevation 1,400 and is currently being operated at elevation 1,450, as opposed to elevation 1,375, the elevation upon which the joint opinion was based. Biological monitoring suggests that high summer water temperatures in the residual pool have not materialized, nor has high turbidity significantly affected bull trout health. While there has been some emigration of bull trout through the diversion tunnel, it does not appear that this has resulted in mortality at significant levels. In addition, the emigration has been managed through incremental adjustments in our ongoing biological monitoring program. When considering this information in the context of growing budgetary constraints, it does not appear reasonable for the agency to make this level of investment in a temporary facility.

The Corps has the discretion to review and recommend changes to uncompleted authorized projects. This can be accomplished through preparation of limited reevaluation and post-authorization change reports. To date, we have not formally reviewed the need for changes in ongoing fisheries management at the Cougar project with an operating temperature control system in place. We believe it is necessary to conduct this review now under the Willamette Temperature Control project. If the review indicates a need for permanent trapping facilities that are clearly tied to environmental changes occurring as a result of the authorized temperature control project, then we have the discretion to recommend changes and request approval to add a permanent trap or other features to the ongoing project.

6.1 2003 Drawdown and Construction. To reduce the intensity or duration of another high turbidity event during April such as occurred in 2002, the Corps investigated possible operational changes. The options currently under consideration include alternative scenarios for winter pool operation, alternative timing for drawdown, and adjusted rates of drawdown. Analysis and observation of conditions during the 3 feet/day drawdown has lead the Corps to consider a faster drawdown of up to 6 feet/day. The Corps geotechnical staff believes that a drawdown rate higher than 6 feet/day could cause excessive slumping of shoreline and possible damage to the dam.

6.1.1 Water Quality Monitoring. Ongoing water quality monitoring will be continued at the gage sites above and below the project and in the reservoir. This monitoring was detailed earlier in this SIR report.

During the 2003 drawdown additional water quality monitoring is being considered that will provide information about outflow turbidity-suspended sediments relationships, deposition of sediment downstream, and export of DDT downstream. To accomplish this, suspended sediments in turbid water will be measured. The concentration of DDT in a range of turbid waters will be measured. Sediment traps will be set out to observe the extent to which settling of sediment occurs at downstream locations. Because of so few winter storms in 2003 and because of late receipt of FY 03 appropriation, the sediment trap studies could not be conducted this year. They are still under consideration for 2004, subject to the availability of funding.

6.1.2 Biological Monitoring. Ongoing biological studies (i.e., regarding bull trout behavior and distribution) and monitoring of potential impacts on fish and wildlife resources will be continued for 1 year following construction. These monitoring efforts are detailed in the BA and BO for the Cougar WTC project and are summarized above.

6.2 2004 Drawdown and Construction Actions proposed for 2004 are a continuation of the 2003 operation, with additions of new BMPs if any are identified.

7.0 NEW CIRCUMSTANCES SINCE THE EARLIER NEPA DOCUMENT

7.1 Turbidity. The Corps addressed the issue of turbidity during drawdown of Cougar Reservoir and during construction of the water temperature control feature in the Cougar Final Feasibility Report (FFR) and EIS. This report stated that turbidity levels in outflows could exceed 100 NTUs (Corps, 1995, FFR p90 and A-39, and EIS pp3-13 and 4-16) and inferred that levels of

200 to 600 NTUs were possible (FFR, p89, 4th par and p90, 2nd par). It was stated that turbidity would be an "unavoidable adverse impact" (EIS, p4-47).

In the EIS, the estimated impact to the mainstem McKenzie River was based on drawdown occurring in late winter, when high turbidity would normally occur because of storm events. Unfortunately, because of bypass tunnel construction delays, drawdown did not occur until spring.

Based on prior Corps experience with drawdown of Fall Creek Reservoir, the intensity of the turbidity event occurring during drawdown of Cougar Reservoir was expected to be relatively low and its duration was expected to be relatively short. Estimates of turbidity that would result from drawdown of Cougar Reservoir were based on up to 10 times turbidity levels actually measured in the reservoir (i.e., up to 10 times levels of 0.6 to 2.9 NTU).

The BA stated, "This turbid water would be discharged for a period of unknown length during initial drawdown of the reservoir, but the turbid discharge would likely occur over a relatively short term period (e.g., 10 days or less) based on observations at other impoundments in the Willamette Basin." This assumption was based on complete drawdown of Fall Creek Reservoir during November and December or 1989 when levels of turbidity were elevated for approximately 9 days.

High levels of turbidity below Fall Creek Dam occurred only when the reservoir level reached bottom (USACE 1995). The operational plan for Cougar Reservoir was to retain a residual pool. This was, in part, to capture sediment and reduce turbidity levels occurring below Cougar Dam.

In addition, it was assumed that, while the fine sediments that would be passed to below Cougar Dam could remain in suspension for long distances downstream (possibly all the way to the ocean), turbidity would primarily affect only the South Fork McKenzie River. This is because the mainstem would dilute turbid waters entering from the South Fork (EIS, p4-17). This dilution did occur during the Spring 2002 drawdown, although turbidity in the mainstem was more noticeable than expected.

On average, the South Fork McKenzie River contributes approximately 20 percent of the mainstem McKenzie River flow below their confluence. Because of dilution and settling, the average turbidity downstream during Cougar Reservoir drawdown was changed from about 100 NTUs near the dam to about 11 NTUs at Hayden Bridge 49 miles downstream (EWEB, personal communication).

Although mainstem McKenzie River flow helped to dilute turbid water entering from the South Fork, the observed levels of turbidity immediately below Cougar Dam were far above the predicted level of up to 30 NTUs. For example, observed turbidity had a median value of 98 NTUs and a mean of 99.0 NTUs over the 33-day period from April 28-May 30. Further, the expected duration of 10 days for the period of elevated turbidity during drawdown was far exceeded by an actual period of 87 days (April 6-July 1), during which mean daily turbidity was above background levels of up to 10 NTUs.

The extent and duration of turbidity that the Corps estimated would occur during drawdown were clearly underestimated, raising concerns that the Corps may have also underestimated associated impacts. The Corps concluded in their BA that significant effects on aquatic resources would not occur based on much lower levels of turbidity than were actually observed during drawdown. In addition, impacts of turbidity on recreational fishing during the March through April fly-fishing season were unanticipated because levels of turbidity were estimated to be relatively low and of short duration below Cougar Dam. They were anticipated to occur during winter, and turbidity levels occurring in the South Fork were expected to be diluted further upon entry into the mainstem McKenzie River.

The higher than anticipated level and duration of turbidity that occurred during drawdown of Cougar Reservoir in the spring of 2002 impacted the local fishing industry. It also raised concerns regarding potential effects of sediment deposition on aquatic resources (e.g., fish, invertebrates, and habitat) and regarding potential re-suspension and export of contaminants (e.g., DDT) borne in the turbid water.

Leaburg State Fish Hatchery reported elevated levels of turbidity in their hatchery water supply. During this period, hatchery managers experienced problems with an increase in disease-related mortality in rainbow trout held at the hatchery. While the hatchery has had a continuing history of disease-related problems, the turbid water conditions caused by Cougar Reservoir drawdown could have exacerbated these problems. Raised levels of suspended sediment in the hatchery water supply may have contributed to stressing of the diseased fish and may have caused some adsorption of therapeutic chemicals to clay particles, thus rendering the chemicals less potent.

This SIR examines the events, circumstances, and related data collected to assist in evaluating the effects of the high turbidity levels experienced during the initial drawdown of Cougar Reservoir in the spring of 2002. It also examines management alternatives for avoiding or reducing the effects of drawdown during the remaining construction periods in 2003 and 2004. A summary and brief chronology of high turbidity events during Spring 2002 follows. Background (i.e., normal) levels of turbidity below Cougar Dam in the South Fork McKenzie River and in the mainstem McKenzie River rarely exceed 50 NTUs and are usually below 10 NTUs (Appendix A).

The maximum turbidity measured below Cougar Dam, which occurred immediately following the bypass tunnel tap on February 23, was 1,358 NTUs. This level decreased to about 8 NTUs within an hour. Over the 5-day period following the tunnel tap, data from the USGS gage located below Cougar Dam indicated mean daily turbidity levels ranging from 21.0 NTUs (Feb 25) to 3.8 NTUs (Feb 27). Mean turbidity over this period was 13 NTUs. Turbidity returned to normal background levels after February 27th until reservoir drawdown commenced in April.

During drawdown (April 1-May 26), turbidity ranged from 1 to 379 NTUs below Cougar Dam. Turbidity spiked over the period of an hour from approximately 20 NTUs to near 200 NTUs on April 9. Mean daily turbidities remained above 30 NTUs (averaging 76 NTUs) for 59 days, through June 6. This was 11 days following the termination of drawdown on May 26.

A week-long spike in mean daily turbidity below Cougar Dam ranged from 112.7 NTUs to 41.4 NTUs and averaged 73 NTUs from April 14-19 (6 days) following a heavy rain event above Cougar Reservoir on April 13. This rain event caused turbidities up to 327.3 NTUs in the South Fork McKenzie River above Cougar Dam that returned to a near-background level of 15 NTUs after only 2 days. These observations demonstrate the effect of the reservoir on turbidity in terms of reducing the intensity, but extending the duration, of high turbidity events below the dam in comparison to natural high turbidity events above the reservoir.

The period of highest turbidity occurred over a 33-day period from April 28 through May 30, 4 days following termination of drawdown. During this period, the South Fork McKenzie River was cutting a channel to the residual pool through the sediment wedge deposited in the upper area of Cougar Reservoir over 39 years of inundation. The residual pool elevation fell below the invert level of the regulating outlet on April 30. Following this date, all discharge from Cougar Reservoir was through the bypass tunnel. Mean daily levels averaged 99 NTUs during the 33-day period of highest turbidity.

In comparison, turbidity at the EWEB water treatment plant intake located at Hayden Bridge, 49 miles downstream on the mainstem McKenzie River, was reported to have reached a high of 26 NTUs, with an average of about 11 NTUs over April and May. This level resulted in the need for additional filtration of raw water during processing.

7.2 Sedimentation

7.2.1 Erosion and Sediment Movement within Cougar Reservoir. Drawdown of Cougar Reservoir below its normal minimum pool level of 1,532 feet to the construction pool level of 1,400 feet resulted in substantial erosion of unvegetated soil surrounding the pool. The major tributary drainage streams flowing into the reservoir, the South Fork McKenzie, East Fork McKenzie, and Walker Creek, re-established channels to the lower pool at the 1,400 foot level. These processes transported large amounts of sediment into the newly created residual pool area at 1,400 feet. Detention time in the construction pool was sufficient to allow the bulk of the coarser grained sediment mass to settle out. Much of the fine-grained sediment mass (silt-clay fraction, grain size smaller then 62 microns) was released from the reservoir during the period from April 1 to May 25, 2002 when the pool level reached 1,400 feet. The fine-grained material released from the reservoir caused extended elevated turbidity in the South Fork McKenzie to the confluence and into the mainstem McKenzie Rivers.

7.2.2 Suspended Sediment Concentration. In order to assess the environmental impacts of the extended period of high turbidity in the South Fork and mainstem McKenzie Rivers on fishes, estimates of suspended sediment concentration were made by the Corps (Appendix D). Estimates of suspended sediment concentrations over extended time periods in the South Fork McKenzie River below Cougar Dam may be made using the measured turbidity at USGS gage, number 14159500 near Rainbow, Oregon. The gage is located just downstream of Cougar Reservoir.

Equations for suspended sediment concentration (SSC) as a function of turbidity are developed using linear regression methods with SSC as the dependent variable and turbidity as the independent variable, and are commonly used to estimate SSC. The equations developed are site

and watershed specific and are typically based on data collected over a wide range of streamflows and basin conditions. Many factors may influence the SSC – turbidity (SSC-T) relationship for any given site, such as the geology of the watershed, soils, vegetation, slope and aspect, and land use (Lewis, et al. 2002). The SSC-T relationship is also affected by the effects of sediment loading over time as exhibited downstream of reservoirs. In general, sediment discharge from reservoirs tends to be higher in fine sediment, as the coarser fraction settles out in the reservoir pool

To provide an estimates of SSC in the South Fork McKenzie River below Cougar Reservoir, the Corps used data from the USGS North Santiam River Basin Suspended-Sediment and Turbidity Study (Urich, et al. 2002). SSC-turbidity relationships were developed for five sites in the North Santiam basin. Three sites were located on tributary streams draining Detroit Reservoir and two sites, Mehama and Niagara were located on the North Santiam below Detroit Reservoir (Appendix D, Figure 1).

The Corps used the SSC-Turbidity relationship at Mehama, Oregon (USGS gage 14183000) to develop its SSC and sediment discharge estimates for the South Fork McKenzie river below Cougar Reservoir. The Mehama data were used because the site was located below Detroit Reservoir, and there is some similarity in the geology and watershed characteristics. In addition to these factors, the SSC samples (CUGRDS1-4) and corresponding observed turbidity (Appendix D, Figure 2) compared favorably with the Mehama data. As the SSC-turbidity relationship is site specific, use of the North Santiam data to estimate SSC and sediment discharge provides a gross estimate.

The computed mean suspended sediment concentration over the period from April 9 to June 6, 2002, was 48.5 mg/liter, the corresponding average turbidity was 76.1 NTU.
Five suspended sediment samples (CUGRDS1-4) were collected just downstream of Cougar Reservoir at the USGS gage at Rainbow, Oregon between April 24 and June 3, 2002. The suspended sediment concentrations (SSC) of these samples ranged from 21 to 86 mg/liter and were between 97 and 99 percent fine sediment (grain size smaller than 0.062 mm). The corresponding measured turbidity when these samples were taken was between 31.8 and 96.8 NTU.

7.2.3 Sediment Transport Analysis. Using the SSC-T relationship from Mehama, Oregon, the Corps estimated that approximately 12,500,000 kg (13,800 tons) of sediment was discharged over the same period. Applying a standard error, the estimate is between 4,530,000 kg (5,000 tons) and 20,500,000 kg (22,600 tons) (Appendix D). No estimate of sediment deposition over the period was made by the Corps. Visual observation of the South Fork McKenzie River gravel bed below Cougar Reservoir and of the mainstem McKenzie River below its confluence with the South Fork indicated the presence of a thin layer of silty material following the sustained releases of highly turbid water from Cougar Reservoir. Most of this material did not accumulate on the surface of the gravel bed but was flushed through the McKenzie River system during subsequent high flows. Some of the fine sediment in suspension accumulated in the algae covering the gravel bed, changing the color of the algae from green to gray.

7.3 Sediment Sampling and DDT.

During the design phase of the project, Geotechnical Resources Inc. submitted 12 surface grab sediment samples for physical and chemical analyses. These samples were collected at the 1,400' contour near the intake structure and diversion tunnel and upstream locations, with results published in the Design Memorandum No. 21. No organic contaminates were detected above method detection levels (MDL) and metals were detected only at low levels and were considered at background levels. However, with the greater than anticipated amount of turbidity during the drawdown process, questions were raised about potential contaminate levels in the turbidity and possible sediment releases, as a result additional sediment sampling was planned.

7.3.1 DDT in Sediment. As a result of questions raised about potential contaminate levels in the turbidity and possible sediment releases, 12 surface sediment samples, targeting fine-grained sediment and organic material, were collected in June 2002. These samples were collected to target fine-grain and organic material that had been eroded during the drawdown, with one sample to represent lakebed sediments exposed after the drawdown event. All samples were submitted for physical parameters including total volatile solids and five samples were chemically analyzed for heavy metals (nine inorganic), total organic carbon, pesticides and polychlorinated biphenyls (PCBs), phenols, phthalates, miscellaneous extractables and polynuclear aromatic hydrocarbons (PAHs).

7.3.1.1 June Event Results: Five samples were tested for pesticides and PCBs. No PCBs were found at the Method Detection Limit (MDL) in any of the samples. No pesticides (except DDT and derivatives) were found at the MDL in any of the samples. Two phthalate compounds were detected in one sample each, and the values were well below established levels of concern (see reference appendix B). No phenols were detected in any samples above MDLs. One miscellaneous extractable (n-nitroso-di-n-propylamine)(DPN) was found in one sample, COUG-G-07. This was not confirmed in the quality assurance (QA) split sample. This chemical is produced primarily as a research chemical and not for commercial purposes (Spectrum). DPN was not considered to be a chemical of further interest.

The following stations were tested for DDT and its breakdown components, DDE and DDD (expressed as Σ DDT) (with corresponding levels as indicated): two samples were collected from East Fork cut banks (Σ DDT @ 8.5 and 32.6 ppb), one sample below the Slide Creek boat ramp, from a cut bank area (Σ DDT @ 23.9 ppb), one sample from the Annie Creek delta (Σ DDT @ 18.6 ppb), and one sample was collected from lake deposits near the face of the dam on the Rush Creek side (Σ DDT @ 5.3 ppb).

7.3.1.2 August Event Results: Fifteen samples were collected and analyzed for physical properties, total organic carbon (TOC) and Σ DDT. Two background samples were collected from the South Fork of the McKenzie above the reservoir (no Σ DDT detected, less than 2.6 percent fines); three vertical profile samples from the cut-bank areas where only the fine-grained sediment was targeted in June (7.27, 7.11 and 17.65 parts per billion [ppb]); five surface composite sediment samples collected from the reservoir to represent the recently eroded and homogenized sediment during the drawdown event (non-detect [ND] @ 0.7 ppb detection level), 1.08, 4.77, 6.19 and 25.87 ppb). Each of these five samples analyzed were a composite of two to

three surface grabs from a designated area of the reservoir; two surface samples from the McKenzie River, downstream of the dam (both ND @ less than 0.7 ppb) in slack water areas, where Σ DDT might have been deposited, if it had migrated beyond the confines of the reservoir. One upland station was sampled on a logging road cut bank. Samples represented the surface to 6" depth and 6"-12" depth of forest floor debris (Σ DDT @ 374.6 ppb top 6") and (Σ DDT @ 36.9 ppb 6"–12" depth). (For more details see attached sediment Appendix B).

It is likely that some floating organic debris (fir needles, twigs, etc.), binding DDT, was released from the reservoir during the initial drawdown, but this material was likely distributed over a very large area, and not measurable nor posing any significant exposure to organisms, due to the wide distribution of this material. Because Σ DDT is hydrophobic (little affinity for water) it will tend to remain bound to the organic material and not released to the water column. (See Appendix B.)

7.4 Oregon Chub.

In the fall of 2000 a viable population of Oregon chub, listed as endangered under the Endangered Species Act, was discovered in the lower McKenzie River near Springfield, Oregon. In addition, a small population of Oregon chub was discovered in the Mohawk River, a tributary of the McKenzie, known to contain agricultural runoff. A memorandum for the record has been prepared to address this discovery. The Corps determined that there would be no effect from construction on Oregon chub. USFWS concurred.

The Cougar WTC Project has the potential to impact Oregon chub residing in the lower McKenzie River through alteration of water quality, but would have no direct impact on Oregon chub located in the Mohawk River. While the project has at times contributed to increased turbidity in the lower McKenzie River, the magnitude of turbidity levels and associated effects has been small in comparison to those occurring below Cougar Dam in the South Fork McKenzie River (See Appendix A). For example, the highest level of turbidity reported by EWEB at their Hayden Bridge treatment facility was 11 NTUs when mean daily turbidity levels below Cougar Dam were averaging 99 NTUs.

Oregon chub are small fish and weak swimmers. Habitat where Oregon chub occur includes ponds and sloughs with little or no water flow velocity, with a depositional substrate of silt and organic materials, and with stands of filamentous algae and emergent aquatic, or overhanging riparian, vegetation as described by Pearsons (1989) and Markle *et al.* (1991). Modest levels of turbidity, such as those reported to have occurred at EWEB's Hayden Bridge plant during spring 2002, would have no adverse effect on these habitat types or on the fishes that occupy them. As a result, we determined that the Cougar WTC Project construction has had no effect on Oregon chub and is unlikely to have effects in the future. A "no effect" determination has, therefore, been made.

7.5 Analysis of High Turbidity on Spawning Gravel

The Corps contracted with the U.S. Forest Service (USFS) and Department of Geosciences at Oregon State University (OSU) to conduct an investigation of fine sediment deposition in

spawning gravels of the South Fork McKenzie and McKenzie Rivers as a result of the drawdown of Cougar Reservoir. A study by Stewart et al. (2002) examined substrate core samples taken from the riverbed to evaluate intrusion of fine sediments into spawning gravels located above and below Cougar Reservoir.

In addition, Stewart et al. (2002) used clay mineralogy analysis to link clay found in core samples taken from the S.F. McKenzie River below Cougar Dam to clay found within Cougar Reservoir. It is not possible, however, to determine when the clay from Cougar Reservoir was deposited below the dam. Deposition could have occurred any time over the past 40 years. A clear linkage to Cougar Reservoir clays was not found in core samples collected from the mainstem McKenzie River, indicating that these deposits likely originated from a combination of sources, including Cougar Reservoir, over a relatively long time period.

Estimation of the specific quantity of sediment deposited in the area immediately below Cougar Dam in comparison to other areas located further downstream was not determinable. The analysis of sediment infiltration into gravel below Cougar Dam indicated that most sediment originating from Cougar Reservoir either before or during the high turbidity events of Spring 2002 was deposited in the South Fork McKenzie River before its confluence with the mainstem McKenzie River (Stewart et al. 2002). This analysis also indicated that the amount of material deposited decreases relatively quickly with distance below the dam.

Data specific to the McKenzie River system that could be used to estimate the relationship between suspended sediment concentration and turbidity was unavailable. As a result, the Corps used USGS data from below Big Cliff Dam on the North Santiam River and associated relationships to estimate suspended sediment concentrations (SSC) occurring in the McKenzie River from observed turbidity levels (Appendix D). From mean daily flow data and corresponding mean daily SSC estimates, the Corps calculated an estimate of the total sediment load that may have been discharged from Cougar Dam during the period April 1 through July 1, 2002. The Corps estimated that from approximately 5,000 to 22,500 tons (13,800 ± 8,800 tons) of fine sediment may have been discharged to below Cougar Dam. Turbidity measurements taken at Hayden Bridge near Springfield, in comparison to turbidity measured just below Cougar Dam, indicated that most of this fine sediment remained in suspension and passed downstream to below the McKenzie Basin.

An unknown portion of the material discharged from Cougar Dam was deposited in the McKenzie Basin. However, visual evidence of a light dusting of gray material on the streambed during and immediately following the high turbidity events of Spring 2002 indicated that at least some material from Cougar Reservoir was deposited throughout the entire McKenzie River system from Cougar Dam downstream. Some of this material will be re-suspended in the water column and washed further downstream during future high flow events occurring over winter. The quantity of material that may be washed from the McKenzie system will depend upon the quantity of fine sediment that was deposited and the depth at which it was deposited in relation to the intensity of over-winter flow events. Sediment deposited nearer the surface of the stream channel substrate will be the most easily re-suspended and moved downstream.

While accumulation of fine sediment has occurred below Cougar Dam over an unknown time period, the high turbidity events during Spring 2002 were unlikely to have had long-term negative impacts on spawning gravel quality below Cougar Dam. However, assessment will be made of the rate of fine sediment accumulation in gravel areas during future storm events over the winter of 2002-2003 to aid in better understanding the dynamics of fine sediment transport and deposition, and its effects on habitat.

7.6 Analysis of High Turbidity on Aquatic Macroinvertebrates

Aquatic macroinvertebrate (benthic) samples were collected above and below Cougar Reservoir in August 2002 following the high turbidity events of Spring 2002.(Figure 4) The sampling design was intended to determine if there had been immediate and catastrophic impacts to benthic invertebrate communities as a result of the recent drawdown of Cougar Reservoir. Where possible, data collected in August 2002 were compared with samples collected by the McKenzie Watershed Council in October 2000 and 2001, prior to the high turbidity events of Spring 2002.

All of the above samples were analyzed by Aquatic Biology Associates, Inc. (Wisseman 1996) according to a standardized and well documented procedure that produces, among other things, a Biotic and Habitat Integrity Index summary score (index score) for each sample site. The analysis procedure and resulting index score consider a combination of factors including 30 metrics for stream margin samples and 53 metrics for riffle samples. These metrics assess taxa (e.g., species) presence, diversity and abundance, and permit assessment of invertebrate community composition and structure. Results from samples collected in the McKenzie River Basin are presented in Figure 5.

Analysis indicated that the macroinvertebrate community below Cougar Dam was degraded (moderate to low index scores) in comparison to the community located above the reservoir (high to low index scores; Table 5). However, this is not unusual for areas located below dams. For example, total index scores for margin habitat immediately below all dams on the Clackamas River were significantly depressed (PGE 2002). This trend was also indicated in South Fork McKenzie River samples collected during 2000 and 2001, prior to drawdown of Cougar Reservoir (Figure 5).

It is likely that the low index score observed below Cougar Dam in August 2002 at Site 4 relative to sampling sites located above the reservoir is related more to total effects from the dam, rather than specifically to increased turbidity during Spring 2002 (Wisseman 2002). Alteration of the historic water temperature regime below Cougar Dam (the correction of which is the objective of the Cougar WTC project) has likely had a strong effect on the structure and integrity of the macroinvertebrate community there. In the Coordination Act Report to the Corps on the Cougar WTC project (April 12, 1995), the U.S. Fish and Wildlife Service pointed out that "where conditions have been altered such that temperatures are uniformly colder, lacking daily and/or seasonal fluctuations…aquatic insect populations are much less diverse (fewer species), with large numbers of individuals of a few species that are suited for these altered conditions" (Stanford and Ward 1983; Ward and Stanford 1979).

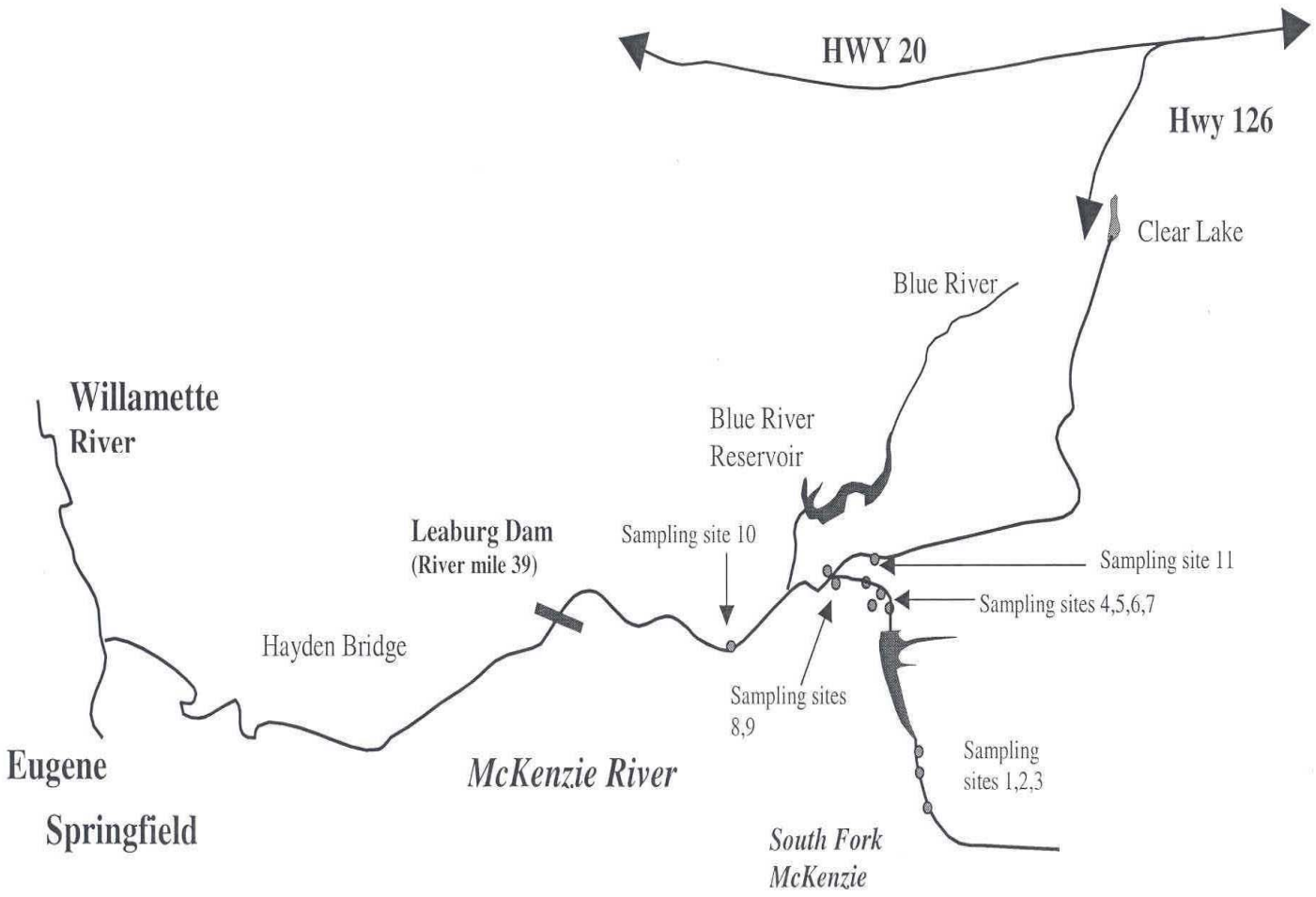


Figure 4

Macroinvertebrate Sampling Sites

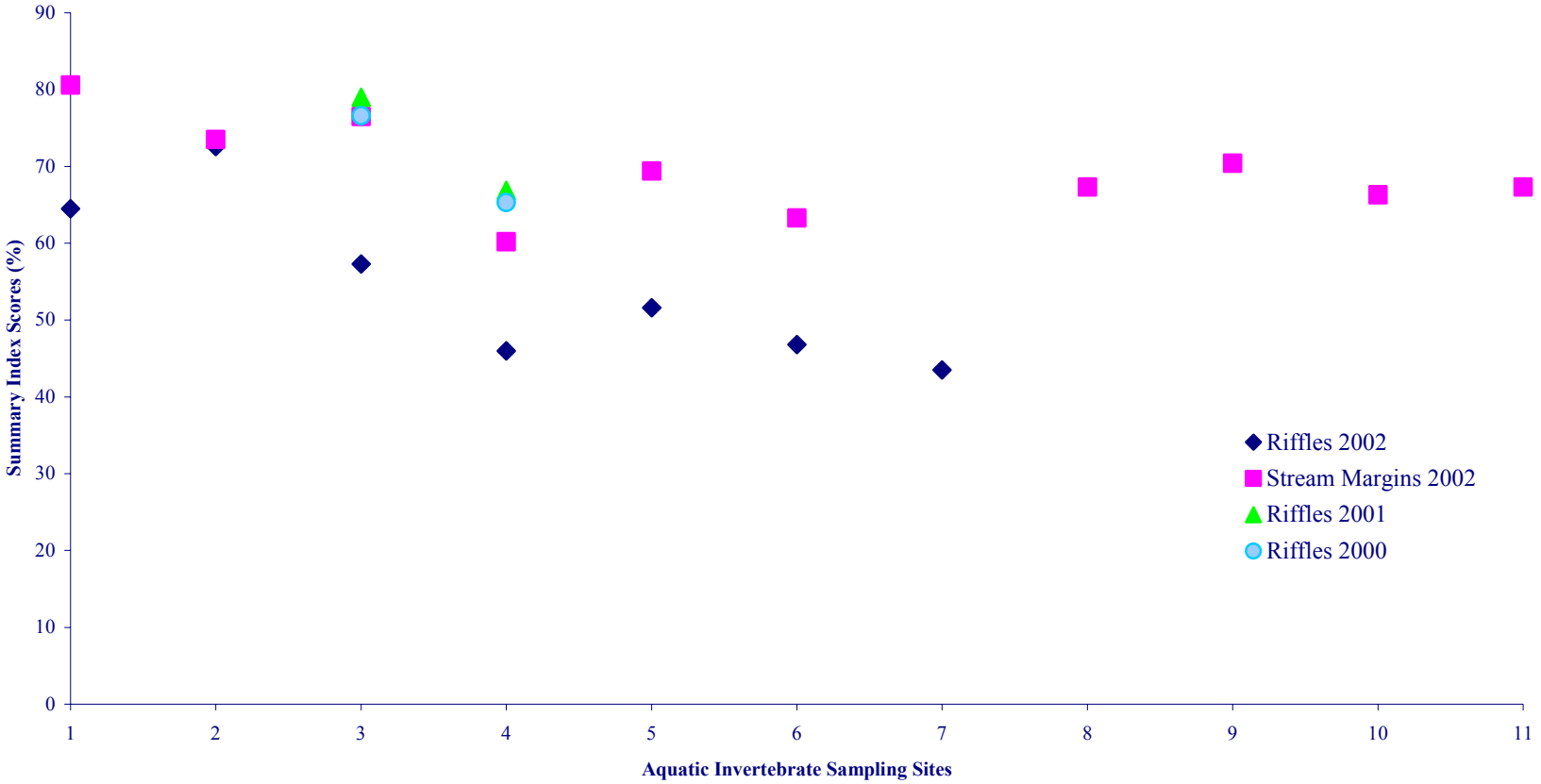


Figure 5. Plot of Biotic and Habitat Integrity Index summary scores (Wisseman 1996) for aquatic macroinvertebrate sampling sites in the McKenzie River Basin, Oregon.

Note: Site locations proceed from upstream to downstream. Sites 1-3 are located in the South Fork (SF) McKenzie River above Cougar Reservoir. Sites 4-7 are located in the SF McKenzie River below Cougar Dam. Sites 8 (right bank) and 9 (left bank) are located in the McKenzie River at its confluence with the SF. Site 10 is located downstream and Site 11 is located upstream of the SF confluence in the McKenzie River.

Table 5. Biotic and Habitat Integrity Index Summary Scores and Classifications (Wisseman 1996) for Aquatic Macroinvertebrate Sampling Sites in the McKenzie River Basin, Oregon.

Sample Site	Sample Year	Sample Type	Location	Index Score	Integrity Class
1	2002	R	SFA,U	64.5	Mod
1	2002	SM	SFA,U	80.6	Hi
2	2002	R	SFA,M	72.6	Mod
2	2002	SM	SFA,M	73.5	Mod
3	2000	R	SFA,L	76.6	Mod
3	2001	R	SFA,L	79.0	Mod
3	2002	R	SFA,L	57.3	Low
3	2002	SM	SFA,L	76.5	Mod
4	2000	R	SFB,U	65.3	Mod
4	2001	R	SFB,U	66.9	Mod
4	2002	R	SFB,U	46.0	Low
4	2002	SM	SFB,U	60.2	Low
5	2002	R	SFB,M	51.6	Low
5	2002	SM	SFB,M	69.4	Low
6	2002	R	SFB,L	46.8	Low
6	2002	SM	SFB,L	63.3	Low
7	2002	R	SFB,SCh	43.5	Low
8	2002	SM	MR,RB	67.3	Low
9	2002	SM	MR,LB	70.4	Mod
10	2002	SM	MR,B	66.3	Low
11	2002	SM	MR,A	67.3	Low

Samples were collected in October 2000 and 2001 and in August 2002 from either riffles (R) or stream margins (SM). Site locations include the South Fork McKenzie River above (SFA) and below (SFB) Cougar Reservoir and the mainstem McKenzie River (MR). Secondary codes indicate upper (U), middle (M), lower (L), and side channel (SCh) sites on the South Fork and sites on the mainstem McKenzie River above (A), below (B), and at the confluence of the South Fork with the mainstem on its right (RB) and left (LB) banks. Possible Biotic and Habitat Integrity Index classifications are very high (Vhi), high (Hi), moderate (Mod), low (Low) and very low (VLow).

The index scores for riffle samples collected in August 2002 were consistently lower than index scores for riffle samples collected in October 2000 or in October 2001 at sites both above (Site 3) and below (Site 4) Cougar Reservoir. This was likely an artifact of the difference in time of year during which the samples were collected (Wisseman 2002).

Index scores indicated that biotic and habitat integrity of macroinvertebrate communities located below Cougar Dam was fairly uniform with distance downstream. That is, habitat for these

organisms and their community structure did not decrease significantly in quality near the dam in comparison to habitat located further downstream.

The index score for Site 11, located in the mainstem McKenzie River above its confluence with the South Fork, was not significantly different from the scores for Sites 8,9, and 10 located in the mainstem McKenzie River at, and about 6 miles below (Site 10), its confluence with the South Fork (Table 5; Figure 5). Because of its location, environmental conditions at Site 11 were not influenced by drawdown of Cougar Reservoir during Spring 2002. The lack of difference in this area from sites located further downstream in the mainstem McKenzie River suggests that degradation of the macroinvertebrate community in all of the areas sampled below Cougar Dam has proceeded over a relatively long time period and did not result from a catastrophic event associated with the recent drawdown of Cougar Reservoir. Further, the abundance of organisms, species diversity, and presence of species sensitive to high levels of turbidity that were found in aquatic macroinvertebrate samples collected from sites located in the South Fork McKenzie River downstream of Cougar Dam suggests that this area was not heavily impacted by the relatively high turbidity events of Spring 2002 (Wisseman 2002).

7.7 Analysis of High Turbidity on Fishes

Direct observations of fish condition were made in response to periods of high turbidity that occurred in the McKenzie River Basin during Spring 2002. These observations were made at multiple locations and times. The results of these observations are presented below.

While these direct observations were important for documenting fish condition, they are point-in-time (and space) samples of the fish community that are representative of, but not equal to, the full extent of impacts that may have occurred. Clearly, practical and logistical limitations prevented the Corps from sampling all segments of the fish community in all areas potentially affected.

In order to better assess the potential extent of impacts to fishes over space and time, available scientific literature was consulted as an aid. Newcombe and Jensen (1996) reviewed "80 published and adequately documented reports on fish responses to suspended sediment in streams" and developed empirical equations relating the biological responses of fishes to concentration and duration of suspended sediment exposure. The equation they developed for exposure of juvenile and adult salmonids to particle sizes ranging 0.5-250 μm in diameter was

$$Z = 1.0642 + (0.6068)\ln d + (0.7384)\ln c$$

where Z is a score indicating the types and severity of ill effects, ln indicates the natural logarithm (i.e., to base e) of the indicated parameter, d is the duration of exposure in hours, and c is the average concentration of suspended sediment in milligrams per liter (mg/l) experienced over time period d.

The Z scores developed by Newcombe and Jensen (1996) ranged from 0-14. The authors determined, for example, that a score of 10 indicates the likelihood of 0-20 percent mortality and moderate to severe habitat degradation. Scores above 10 indicate the likelihood of higher levels

of mortality, while lower scores indicate lesser effects such as reduced growth rate ($z = 9$), major physiological stress and reduced feeding rate ($z = 8$), moderate habitat degradation ($z = 7$), moderate physiological stress ($z = 6$), or minor physiological stress and increased respiration rate ($z = 5$).

The z scores were determined using the above formula for key turbidity events and periods following the bypass tunnel tap and during the Cougar Reservoir drawdown. This approach was used as a means of assessing potential effects of high turbidity on spring chinook salmon, summer steelhead, rainbow trout or other salmonids present in the South Fork McKenzie River below Cougar Dam or in the mainstem McKenzie River below its confluence with the South Fork. In addition, the direct observations of the condition of fishes that were made during these events and periods by biologists and pathologists as a result of ongoing biological monitoring associated with implementation of the Cougar WTC project were helpful in confirming results obtained through determination of z scores.

In order to calculate z scores, suspended sediment concentrations (SSC) associated with observed turbidity levels (T) were estimated. Systematically collected data directly relating turbidity levels above or below dams in the McKenzie River Basin to suspended sediment concentrations were not available.

The Corps collected a few water samples at various sites in the McKenzie River Basin during the high turbidity events of spring 2002 (Table 1) The size range of particles contributing to suspended sediment in the water samples collected from the McKenzie River downstream of Cougar Dam (i.e., 0.5-250 µm in diameter) was identical with the range of particle sizes for which Newcombe and Jensen (1996) estimated effects on juvenile and adult salmonids.

Because of the limited number of samples (N=5) available from below Cougar Dam in the McKenzie Basin, data and equations from studies performed by the U.S. Geological Survey (USGS) in the North Santiam River (Uhrich et al., 2002) were used. This information was supplemented with analyses performed by the U.S. Army Engineer Research and Development Center, using sediment samples collected directly from Cougar Reservoir. The Corps concluded that the best relationship between suspended sediment concentration and turbidity for use in the McKenzie River Basin was given by the equation $SSC=1.90T^{0.752}$ for low to moderate turbidity levels and by the equation $SSC=0.55T+83.45$ for relatively high (greater than 200 NTU) turbidity levels (Appendix D). These equations were used to convert mean turbidity data into estimates of suspended sediment concentration for calculation of z scores.

To estimate the potential effects of turbidities observed during Spring 2002, the Corps determined z scores for each turbidity event based on the relationships of suspended sediment concentration to turbidity presented above and in Appendix D.

7.7 Analysis of Tunnel Tap and Drawdown Events on Fishes

The maximum turbidity recorded below Cougar Dam during the bypass tunnel tap on February 23 was 1,358 NTUs. This level of turbidity occurred at initiation of the tap and persisted for less

than a half hour. Turbidity returned to near background levels of 8 NTUs within an hour of the tap.

Assuming a duration of 1/2 hour, the *z* score for this initial high turbidity event would be 6 (at 830 mg/l SSC), indicating the possibility of moderate physiological stress for salmonids present below the dam during the tunnel tap.

The mean daily turbidities over the 5-day period (February 23-27) following the tunnel tap averaged 13 NTUs. The *z* score computed for this period was also 6 (at 13 mg/l SSC), indicating the possibility of moderate physiological stress to salmonids located near the dam throughout the 5-day period following the tunnel tap.

Over the 59-day period (April 1 – June 6) when mean daily turbidities exceeded 30 NTUs, the average turbidity was 76 NTUs (48 mg/l SSC). Mean daily turbidities averaged 99 NTUs (60 mg/l SSC) over the 33-day period of highest turbidity. The *Z* score for both of these turbidity events was 8, indicating the possibility of effects such as major physiological stress and reduction in feeding rate. No mortalities, however, ($z \geq 10$) were indicated.

ODFW examined the health of wild fish collected from the McKenzie River between Armitage Park and Harvest Lane on May 20, approximately one week prior to completion of Cougar Reservoir drawdown. Of those fish examined, juvenile trout 4-6 inches in length appeared to be healthy and in good condition. Adult rainbow trout appeared gaunt, but within the normal range of condition for this post-spawning period. Cutthroat trout ranging 6-12 inches in length were in very good to excellent condition. These fish spawn earlier in the year and would have had more time to recover from spawning period stresses. Fifty-three subyearling spring chinook salmon were examined and found to be in good condition. Other resident fish species examined (i.e., largescale sucker, redside shiner, and northern pikeminnow) also appeared to be in good condition (ODFW Apr-Jun 2002 Quarterly Report).

Sub-samples of adult rainbow and cutthroat trout and 6 juvenile trout were examined more closely by ODFW fish pathologists. These examinations corroborated the results of the above field observations. Stomach content analysis indicated that most fish had been feeding normally (ODFW Apr-Jun 2002 Quarterly Report).

ODFW pathologists also examined juvenile spring chinook salmon, whitefish, and rainbow trout captured on May 21 in a trap fished in the upstream end of the Cougar residual pool. Both rainbow trout and whitefish appeared healthy. The juvenile spring chinook had swollen tips on their gill filaments and clouded eyes. These condition factors may have resulted from trapping and handling stress as water temperatures near the trapping site were relatively high (ODFW Apr-Jun 2002 Quarterly Report).

As expected and discussed in the BA, some bull trout and other fish species were stranded in areas of the drawdown zone during drawdown. Attempts were made to salvage bull trout and other species (i.e., rainbow trout, juvenile spring chinook salmon, dace, cottids, whitefish, lamprey, and crayfish) where possible. Difficulty with access and operating logistics, warm water temperatures, and high turbidity hampered rescue efforts. Fish were in poor condition

upon release into the residual pool. Some bull trout mortalities resulted (ODFW Apr-Jun 2002 Quarterly Report). Biological monitoring to date has not revealed any other impacts to bull trout.

The Corps worked with ODFW to identify and modify key areas in the drawdown zone where fish were stranded during drawdown. As a result, stranding of fish in these areas during subsequent drawdown events should be avoided. Monitoring during drawdown will be continued.

8.0 EFFECTS OF PROJECT ACTIVITIES NOT PREVIOUSLY EVALUATED

8.1 Turbidity (Water Quality). The impact of turbidity on water quality was mainly related to esthetics. The turbid water below the project during April through May was unusual for this time of year, at least for the last 40 years since the project was built, and was esthetically displeasing. Contaminants analysis revealed that no water quality criteria were violated for any contaminant of concern, including metals, PAHs, oganochlorinated pesticides, chlorinated herbicides, and organophosphorus pesticides. Oxygen, temperature, pH and conductivity levels were within normal limits. Particles in the water contributing to the turbidity were mostly clay-sized that remain in suspension for a long time.

Drawdown of Cougar Reservoir below its normal minimum pool level of 1,532 feet to the construction pool level of 1,400 feet resulted in substantial erosion of unvegetated soil surrounding the pool. The major tributary drainage streams flowing into the reservoir, the South Fork McKenzie, East Fork McKenzie, and Walker Creek, re-established channels to the lower pool at the 1,400 foot level. These processes transported large amounts of sediment into the newly created lower pool area at 1,400 feet. Detention time in the construction pool was sufficient to allow the bulk of the coarser grained sediment mass to settle out. Much of the fine-grained sediment mass (silt-clay fraction, grain size smaller then 62 microns) was released from the reservoir during the period from April 1 to May 25, 2002 when the pool level reached 1,400 feet. The fine-grained material released from the reservoir caused extended elevated turbidity in the South Fork McKenzie to the confluence and into the mainstem McKenzie Rivers. Visual observation of the South Fork McKenzie River gravel bed below Cougar Reservoir and of the mainstem McKenzie River below its confluence with the South Fork indicated the presence of a thin layer of silty material following the sustained releases of highly turbid water from Cougar Reservoir. This material did not accumulate on the surface of the gravel bed but was flushed through the system during subsequent high flows. In addition, some of the fine sediment in suspension accumulated in the algae covering the gravel bed, changing the color of the algae from green to gray.

Starting in November 2002, the operating plan for Cougar was to hold reservoir pool elevations within a target range of 1,400 to 1,410 feet. This is a different scenario than occurred during the Spring 2002 drawdown when the starting elevation was 1,532 feet and the reservoir was drawn down to 1,400 feet. As winter storms bring increased flows into the reservoir, the pool elevations will fluctuate and the pool will fill to levels above 1,410. The pool will then be drawn down at a rate not to exceed 6 feet per day.

Many factors may influence the turbidity levels of the discharge from the reservoir. Turbidity levels in the inflows from the tributaries entering Cougar reservoir may possibly reach as high as 400 NTU's. The resulting turbidity from these turbid inflows will be diluted in the lower reservoir pool, and passed on downstream. If a density current forms, then the dilution effect of the lower pool will be reduced and this highly turbid flow would be released from the reservoir. Utilizing the higher drawdown rate of 6 feet per day will clear the turbid water from the reservoir and downstream more quickly. Highly turbid flows from the tributaries entering Cougar reservoir are relatively rare and very short in duration. Median observed turbidity from the South Fork McKenzie above Cougar was 0 to 11 NTU range from November 2000 to January 2003.

The most likely source of turbidity will be from local erosion within the reservoir during rapid fluctuations in the pool levels during storm events throughout the winter and early spring. Operation of the reservoir throughout this period will expose erodable material in the reservoir below the normal flood control level of 1,532 feet to deposition into the fluctuating reservoir pool. As the pool level rises, discharges from Cougar could raise turbidity levels below the dam up to 350 NTU for brief periods. The rise in turbidity will be sharp, and the decline will be more gradual as the pool level is brought down to 1,400 feet. A turbidity level of 202 NTUs was recorded on December 31, 2002. As the winter progresses and storms cycle through, the peak turbidity levels should decrease as the erodable material in the lower pool is reduced by the pool fluctuations. The drawdown rate of 6 feet per day will help to clear the reservoir of turbid water faster than the drawdown rate of 3 feet per day did in Spring 2002.

Spring storms could still result in increased turbidity below the dam but the turbidity will be of shorter duration.

In 2003, it was proposed that the reservoir elevation be held as close to 1,400 feet as possible, and that a reservoir drawdown rate of 6 feet per day be used to accomplish and maintain this. The impact of this operation on turbidity during late spring storm events will depend on pool elevation. If the pool is successfully maintained at elevation 1,400 feet, turbidity will be higher because there is less volume to dilute the suspended sediment, but the turbid water will clear more quickly because of a reduced retention time. If the lake elevation is higher, the turbidity may be less but clearing of the pool will take longer. The drawdown rate of 6 feet per day will help to clear the reservoir of turbid water faster than the drawdown rate of 3 feet per day did in 2002.

The Corps has maintained the residual pool at (or close to) 1,400 feet since May 2002. A December rainstorm increased incoming flows and turbidity, resulting in the pool rising to 1,411 feet, and releases of turbidity up to 200 NTUs on December 30. Incoming turbidity in the South Fork reached 24 NTUs late on December 29, thus the downstream turbidity was about a 10-fold increase, as originally predicted. Turbidity at Hayden Bridge rose to 24 NTUs during that storm. (Average for December was 3.72 NTUs at Hayden Bridge.) (EWEB, pers. comm. Jan. 2003) The Corps was able to draw the reservoir back to 1,400 feet by January 1, 2003. Another rain event elevated the pool to 1,413 on January 5; however turbidity remained below 120 NTUs and dropped below 10 NTUs by January 8. Turbidity in January had not exceeded 120 NTUs, and generally has been between 55 NTUs and 3 NTUs (as of January 22, 2003).

With the January 30, 2003, storm event and the failure of the Rush Creek outlet, turbidity levels were high. Raising the pool to 1,450 feet reduced slope erosion at Rush Creek. Turbidity dropped to 2 NTUs by March, and have remained low during the Spring fishing season for 2003, with the pool maintained at 1,450 feet. Thus the Corps expects that turbidity in the Spring 2004 also will be greatly reduced from the 2002 levels. (See Section 2.3 of the SIR.)

During the operation in winter of 2003, the Corps was considering that sediment transport out of the reservoir be studied through two types of sampling. First, sampling at the USGS gage located downstream of the dam should be conducted to determine the suspended sediment concentration associated with different levels of turbidity. Second, sediment traps should be placed downstream of Cougar Dam to determine how much sediment settles out from turbid water leaving the reservoir. Sediment trap studies could not be conducted this year. They are still under consideration for 2004, subject to the availability of funding.

8.2 DDT in Sediment. Total DDT was exposed in cutbank areas within the reservoir, which eroded into the post-drawdown 1,400 foot pool, but was not measurable downstream of the dam. Total DDT levels detected within the 1,400 foot pool were 4.8, 6.2, 1.1, ND @ less than 0.6, and 25.9 ug/kg (ppb). Further erosion will occur within the pool, but will likely be less than the original drawdown event and will therefore not create further risk downstream. The sediments within the reservoir will be further redistributed with upcoming winter and spring events. Monitoring after the final deposition and distribution within the reservoir would be warranted to determine if natural attenuation will sufficiently isolate the Σ DDT from potential uptake by benthic organisms.

Four of five sediment samples collected within the reservoir did not detected Σ DDT above levels of concern. Sediment will continue to be deposited onto the reservoir bottom. The current area, within the reservoir, where Σ DDT exceeds reference levels of concern is limited and will likely change with future deposits and should be continually monitored, as should, the area below the dam.

No Σ DDT, at MDLs, was detected in sediment samples collected below Cougar Reservoir. A no effect determination has been made for this area.

Because of concerns regarding sediment transport out of the reservoir and the potential for export of DDT, additional monitoring will be considered to address these concerns. The nature of the material contributing to the turbidity, which reduced light penetration in the water, which may have impacted the aquatic community will be discussed in the section on fisheries and macroinvertebrates.

8.3 Spawning Gravel. Results of core samples taken of the spawning gravels in the South Fork McKenzie River below Cougar Reservoir and in the mainstem McKenzie River showed higher accumulation of fine sediments in the samples in the South Fork McKenzie than was present in the samples from the mainstem McKenzie River. Further analysis of the mainstem McKenzie River samples did not find clear evidence of Cougar Reservoir sediments based on the clay mineralogy (Stewart et al., 2002). These results suggest that relatively little of the sediment

discharge from Cougar reservoir settled in any one location in the mainstem McKenzie, though as discussed above, a fine dusting of deposited material was evidenced. The analysis by Stewart et al. (2002) also cannot ascertain when sediments were deposited below Cougar Dam. They may have accumulated over the 40 year time period in which the reservoir has been in place.

While accumulation of fine sediment has occurred below Cougar Dam over an unknown time period, the high turbidity events during Spring 2002 were unlikely to have had long-term negative impacts on spawning gravel quality below Cougar Dam. However, assessment will be made of the rate of fine sediment accumulation in gravel areas during future storm events over the winter of 2002-2003 to aid in better understanding the dynamics of fine sediment transport and deposition, and its effects on habitat.

8.4 Macroinvertebrates. The abundance of organisms, species diversity, and presence of species sensitive to high levels of turbidity that were found in aquatic macroinvertebrate samples collected from areas located downstream of Cougar Dam indicated that this area was not heavily impacted by the relatively high turbidity events of spring 2002. Analysis indicated that the macroinvertebrate community below the dam was degraded in comparison to the community located above the reservoir. However, this is not unusual for areas located below dams, and this trend was also indicated in samples collected during 2000 and 2001 prior to drawdown of Cougar Reservoir (Figure 5). Indexes of biotic and habitat integrity (Wisseman 1996) ranged from moderate to low integrity for sampling stations located downstream of Cougar Dam.

8.5 Fisheries. The high turbidity events of spring 2002 had only minor, transient, impacts on fishes directly and relatively little effect on their habitat. Application of a scoring system developed by Newcombe and Jensen (1996) for relating magnitude (i.e., concentrations) and duration of suspended sediment events to effects on salmonids resulted in scores (z) ranging from 6 to 8 for levels of turbidity occurring directly below Cougar Dam. These scores indicate that impacts to salmonids in the South Fork McKenzie River resulting from the high turbidity events of spring 2002 may have ranged from moderate physiological stress ($z=6$) to major physiological stress and reduction in feeding rate ($z=8$) during the period of high turbidities.

However, assessments of condition for multiple fish species sampled both from below Cougar Dam and from within the residual pool above the dam by ODFW biologists and pathologists failed to detect health-related problems and documented that most fishes sampled were actively feeding and in good condition.

8.6 Aquatic Vegetation. There have been anecdotal reports of increased plant growth in the mainstem McKenzie since construction began at Cougar Dam in 2001. A combination of decreased light, increased turbidity, possibly increased nutrients such as phosphorus and organic carbon, and different water temperatures may have increased plant growth in the mainstem McKenzie. Or, the increased plant growth may have been a normal between years variation. Once construction of the temperature control structure is over, conditions should return to as before except for one environmental variable - temperature. Temperature in the South Fork will return to pre-dam conditions.

For the past 39 years, since the dam was built, the South Fork and the mainstem McKenzie Rivers, probably as far as Vida have not been "natural" in terms of historic conditions that fish and human residents experienced. In other words, the river as now experienced, is not the normal, natural, pristine river. The purpose of the construction project is to return the South Fork and mainstem to more natural conditions. The aquatic organisms that now inhabit the rivers are adapted to current conditions. Some changes in aquatic communities that reflect the restored natural conditions can be expected.

8.7 Socio/Economic. The 2002 Cougar drawdown had a negative effect on trout fly-fishing on the McKenzie River that was not anticipated or evaluated in the FR/EIS. On April 1, the Corps started drawing down Cougar Reservoir in order to install a multi-level intake tower, which would release water into the river at temperatures appropriate for threatened species of fish. That sent accumulations of clay into the river and turned it a brownish-gray color. This caused turbidity levels to spike more than anticipated. Then, on May 26, the Corps stopped drawing down the reservoir. According to the *Springfield News*, by June 12 the turbidity had dropped back to normal levels.. The *Springfield News* also noted that one of the fishing guides reported staying away from the river from April 14 until June 5. The guide indicated that while the McKenzie was not back to its typical clarity by that time, the fishing was good and the river was getting near record runs of steelhead and salmon.

The turbidity problem affected fishing guides, lodges, motels, gas stations, restaurants, and small grocery stores, according to the Convention and Visitors Association of Lane County (CVALCO). CVALCO, the McKenzie River Chamber of Commerce, and the river guides association mailed out a survey to lodge owners and other local business owners. It was called "Cougar Reservoir Draw-Down Economic Impact Survey" and included questions about type of business, comparative gross revenues from 1999 to 2002 (or, change in gross revenues), customer counts (1999 to 2002), and cancellations or other declines in business attributable to turbidity of the McKenzie River or other Cougar Reservoir draw-down-related factors.

A news release from the McKenzie River Chamber of Commerce and the Convention and Visitors Association of Lane County summarized the results of the survey, as follows. "During March, April and May, area businesses reported 301 cancellations, resulting in lost revenues of $88,656. Most of the losses were reported by river guides, with $15,000 to $16,000 of lost revenue reported by lodging, retail and other business owners. Customer counts dropped by 445, from 1,723. Guide-related revenues were down $48,712 compared to the same time last year. Other survey respondents noted that poor river conditions resulted in a lower call volume with fewer bookings. A total of 27 businesses responded to the survey reflecting only a partial sampling of the overall impacts."

The survey is in no way used as a projection. Neither is it a claim to have captured total area economic losses. As CVALCO noted in their press release, "A total of 27 businesses responded to the survey reflecting only a partial sampling of the overall impacts." In a February 14, 2003, comment letter on the draft Supplemental Information Report, CVALCO also noted that "Reporting was not uniform (some surveys were partially blank). Some responses lacked financial data and indicated only that they were having to abandon their business, or included estimates of lost customers but not related financial impacts. CVALCO was very careful to

stipulate in its release of data that results were based on a small response and not representative of total economic losses."

These comments regarding the survey reveal some of the inherent difficulties found in gathering specific information on economic or financial impacts, whether using various survey instruments or direct contacts. Not everyone is willing to provide such information. The survey simply presents a summary of the information provided by the 27 businesses who did respond to the survey.

To help put economic impacts in a local context for the reader, some illustrations of claimed losses from a June 7, 2002, letter from the attorney for the President, McKenzie River Guides Association are included here.

"1. Income for some of the resorts is down for the March to May months is down $10,000 to $20,000.

2. McKenzie River Guides Association members have had clients cancel over one hundred fishing days with clients.

3. A Walterville store which usually sells 200 fishing licenses by the end of May, as well as selling associated bait, tackle and other fishing supplies, has only sold about ten licenses to date.

These examples indicate that the recent, prolonged sediment pollution on the mainstem of the McKenzie has led to socio-economic impacts unforeseen in the original EIS or the Supplemental EA."

Locals indicate that these impacts have been difficult, particularly for smaller businesses that are very dependent on the summer tourism season. Some of the businesses operate near capacity for a relatively short season, and don't have the capacity to make up for early losses later in the season. There is local concern that if the same impact recurs over the next few years, there will be more lasting damage to the local tourism economy.

Congressman DeFazio has sponsored legislation for some compensation for losses in the Water Resources Development Act legislation. If that occurs, the incentive of compensation may result in more than 27 respondents submitting claims of economic impact, thereby increasing the $88,656 figure for lost revenues.

8.8 EWEB. Eugene Water and Electric Board manages the municipal water supply for Eugene. The intake for the water supply plant withdraws from the McKenzie River near Hayden Bridge, 49 miles downstream from Cougar Dam. EWEB tested for several water quality parameters related to construction at Cougar Project. During the drawdown, turbidity fluctuated between 2 and 26 NTUs. The average turbidity recorded at Hayden Bridge during the 2 month period (April and May) was 10.3 NTUs compared to 2.6 NTUs for the same time period in 2001. Based on treatment plant criteria, additional chlorine was used when the river water exceeded 3.0 NTUs. The additional turbidity needed a slightly higher alum dosage (about 2 mg/l), additional lime for pH adjustment and substantially more backwash water (with corollary return to the

river) during the drawdown. Subsequent to the drawdown period, EWEB tested sludge for presence of DDT and found neither DDT nor any breakdown products. EWEB did have concerns that, should turbidity exceed 3.0 NTUs during high demand summer months, they would not have the capacity to do extra filtration to meet that demand. Additional chemical usage and filtration, an increase in power and staffing was required during the Spring. These additional treatments added extra costs to the usual treatment costs. The Corps agreed to hold Blue River Reservoir full and release additional flow late in the summer season to dilute turbidity in the McKenzie. This action was not necessary in 2002.

9.0 ENVIRONMENTAL EVALUATIONS AND COORDINATION

9.1 Evaluation/Mitigation. The situation regarding turbidity and sediment has been evaluated as described above. While turbidity during the 2002 drawdown exceeded predictions in the mainstem McKenzie River, levels were not unusual for historic late winter-early spring flood events. The drawdown did occur later in the Spring than predicted, making turbidity more noticeable and interfering with the trout fly-fishing season. The Corps stopped the drawdown at 1,400 feet elevation, instead of continuing to lower the pool to 1,375 as originally proposed, and the water cleared to less than 15 NTUs by June 15.

This situation can be mitigated during the remaining 2 years of construction by operating the reservoir at 1,400 (now 1,450) foot elevation year-round to the extent possible. Levels exceeding 1,400 (1,450) feet will be drawn down at the rate of 6 feet/day instead of the previous 3 feet/day. This should allow the reservoir to be at 1,400 (1,450) feet by March 1, and returned to 1,400 (1,450) feet more quickly if there is a major Spring storm. Turbidity will continue to be monitored during construction years.

Levels of DDT above concern were not found below Cougar Reservoir. Monitoring will continue during construction years.

Deposition of fines and insect occurrence were evaluated during the summer/fall of 2002. More fine sediments were found in cores samples from the South Fork McKenzie than in the mainstem McKenzie, but there is no way to know when the fines were deposited. Insect occurrence below the dam is different than above the dam; however, this is typical for below and above dams. Insects populations were varied and numerous below the dam.

Assessment of fisheries below the dam indicated only minor, transient impacts to fishes and little effect on their habitat.

Income losses in 2002 due to reduction of trout fly-fishing and associated expenditures were evaluated by the Convention and Visitors Association of Lane County (CVALCO). Legislative action may provide some mitigation for these losses.

Actions by EWEB due to turbidity in municipal water supply intake have been described. Additional filtering was required during the Spring, but not during Summer months. Water is available from Blue River Reservoir to dilute turbidity in summer months should this become a problem.

Actions at the ODFW fish hatchery at Leaburg included adding additional chemicals to treat the fish.

9.2 Significance. Effects of turbidity in the South Fork of the McKenzie and the McKenzie mainstem during construction drawdown of 2002 were primarily local and esthetic. There are no indications that fish or aquatic invertebrates were adversely affected. Fishing later in the season was quite good (Stahlberg, 2002.) Fall spawning in the South Fork noticeably increased in 2002 due to river water approaching pre-dam levels, a strong indicator that the purpose of the temperature control project will be achieved. Total spring chinook redds below Cougar Dam increased from 61 in 2001 to 108 in 2002. This increase occurred below USFS Road 19, about 2.4 miles below the dam; above the bridge there was a decrease in redds from 44 in 2001 to 24 in 2002. This was a good year for spring chinook, thus all of the increase is not necessarily due to the restoration of normal stream temperatures (ODFW, pers. comm. 2003).

There was an unexpected financial impact on the local economy. Interference with spring trout fly-fishing was not anticipated. According to CVALCO, local residents and businesses reported losses totaling about $88,656. While this may have caused temporary hardship for local residents, it is not regionally or nationally significant, given that the 2002 Oregon Employment Department Regional Economic Profile indicates that the Eugene MSA (Lane County) had a 2000 population of 323,950 people, with a per capita income of $25,584, resulting in total income of approximately $8.3 billion dollars in the regional area. Springfield is the nearest city for which the Oregon Employment Department 2002 Regional Economic Profile provides statistics on population. It had a 2000 population of 52,864. (Neither the Oregon Employment Department or the Portland State University Population Research Center provide information on smaller communities such as Walterville, Leaburg, Vida, Blue River, and McKenzie Bridge.) The U.S. Census Bureau, Census 2000, shows 1999 per capita income of $15,616. Using the local Springfield population of 52,864 people, with a 1999 per capita income of $15,616, results in a total income of approximately $825.5 million in the Springfield area. Recognizing that the losses actually reported may not capture the total economic losses that resulted from the Cougar drawdown, even a substantial increase in losses would not be regionally significant, or in the more local context of Springfield. It is recognized that there were unanticipated disruptions to individuals in local communities, and those affected have concerns about economic impacts to their businesses. Recompense is a possibility via legislative action. The local and regional economy also benefited from construction related expenditures, although no estimate of that benefit is available. With changes in operation of Cougar Reservoir during the remaining construction years, interference with trout fly-fishing season and subsequent economic loss is not expected to re-occur or be as pronounced as in 2002. Heavy spring storms, however, could still result in turbid conditions. In fact, a winter storm resulted in high turbidity and flows. By holding the pool at 1,450 feet, turbidity below Cougar was back to 6 NTUs by the March trout season. While low NTUs during the entire fishing season cannot be assured, the Corps has taken and will continue to take all available measures and practices to reduce disruption during the 2 remaining years of construction.

9.3 Coordination. Throughout the pre-construction and construction process, the Corps has coordinated with Federal and State resources agencies, local governments, interest groups and the public. Since publication of the Feasibility Report/EIS in 1995, the Corps has coordinated the

project with the ECC as described above. The Corps also held public meetings on May 22, 2002, and February 12, 2003, and has maintained an information website.

This Supplemental Information Report and accompanying EA amendment has been coordinated with Federal and State resources agencies, local governments, interest groups and the public. These draft documents were distributed for 30-day review, beginning January 30, 2003. During the review process, operation of Cougar Reservoir continued as described in this SIR. The ECC has been notified of the necessity of continuation of interim actions during the review and preparation of final documents.

9.4 Review Comments and Responses. The Corps received six written comments on the EA/SIR as a result of the meeting, mailing and internet posting. Comments were received from the National Marine Fisheries Service (NMFS), the McKenzie Watershed Council Water Quality Monitoring Committee (MWWQC), Eugene Water and Electric Board (EWEB), William C. Carpenter Jr., Kari Westlund (CVALCO),and David Rodriguez. Comments are summarized and responded to in the attached EA amendment. Changes have been incorporated into this final document.

10.0 FINDINGS AND RECOMMENDATIONS

10.1 Findings. The reservoir drawdown was scheduled to start in January 2002 but did not occur until April. Turbidity which would have been less noticeable in February and March, when turbid flood flows are typical, was highly noticeable and esthetically displeasing in April and May. The flow of turbid water from Cougar Lake occurred during the trout fly-fishing season, resulting in economic loss to local residents. This situation did not reoccur in 2003.

The amount of turbidity below Cougar Dam during drawdown was not known prior to construction. Estimates in the FR/EIS and FDM No. 21 acknowledged uncertainty; estimates ranged from 10-fold increase above stable reservoir levels of 0.6 to 2.9 NTUs to 600 NTUs, which occurred when Fall Creek Reservoir was drawn down in 1989. Estimates of sediment moved and redeposited, as given in the FDM, are probably higher than what actually occurred and will occur over the next 2 years; however, the relationship of silty sediments to downstream turbidity was not adequately communicated.

Water quality, including turbidity, has been analyzed since construction began in 2000. Other than turbidity, water released from Cougar Reservoir during construction has not exceeded State standards. It was acknowledged that turbidity probably would exceed State standards; notification and coordination with Oregon Department of Environmental Quality occurred as required.

During construction monitoring of sediments, DDT and its derivatives were discovered in sediments in the pool drawdown zone. This probably results from forest spraying prior to construction of Cougar Dam. DDT was exposed in four cutbank areas tested within the reservoir, which exceeded established levels of concern for the protection of the aquatic environment. One of five samples collected in the post-drawdown 1,400 foot residual pool, exceeded established levels of concern, but was not detectable downstream of the dam. Even

with re-distribution of sediments within the reservoir due to drawdown, there is no indication that DDT above levels of concern have been or likely will be carried into the river system. Levels of concern to humans were not exceeded in any of the samples tested.
Sampling of macroinvertebrates below Cougar Dam, in both the South Fork McKenzie and McKenzie mainstem shows no appreciable change in quantities of insects from above the reservoir. Changes in species differ above and below the reservoir; however, that is normal for such areas.

Turbidity in the South Fork and mainstem McKenzie during trout fly-fishing season resulted in loss of fishing opportunities. The CVALCO survey resulted in a partial response of 27 respondents who reported $88,656 in lost income. If more people had responded to the survey, that figure for lost revenues might have been higher. EWEB had to temporarily increase filtration, chemical treatment and staff, and ODFW had to increase antibiotic treatment of hatchery fish.

Due to the failure of the Rush Creek outlet on January 30, 2003, turbidity increased temporarily. To avoid continued slope erosion at the outlet, the pool was raised to elevation 1,450. The project has continued to operate at elevation 1,450, drawing the pool down at the 6 feet/day rate whenever inflow causes the pool to rise above 1,450. Erosion of the outlet slope does not compromise dam safety and no immediate repairs are planned. The Corps will continue to monitor and assess this situation.

10.2 Recommendations.

Based on the above information and additional technical documentation in the appended material, it is recommended that the following modifications be adopted:

Reservoir operation will keep the pool at 1,450 foot elevation year-round as much as possible. Flood control operations will be maintained, with the pool drawn down to elevation 1,450 at the rate of 6 feet/day below the normal flood control pool of 1,532 feet. Blue River Reservoir will be operated normally, as described above.

Monitoring for water quality and sediments, including DDT, will continue.

Biological monitoring above and below Cougar Dam will continue. Monitoring of spring chinook fry emergence from redds located below Cougar Dam will be added to currently ongoing monitoring tasks. If turbidity below Cougar Dam exceeds 30 NTUs for more than 10 days, a fish sampling protocol will be implemented to document any changes in fish condition that may occur. (This protocol was implemented after discussions with NMFS and with others on the Environmental Coordination Committee subsequent to the January 30, 2003, storm and failure.)

The Corps of Engineers is not currently authorized to compensate for losses to individuals. However, if legislation is passed to provide compensation, the Corps will implement the legislation to compensate for economic losses.

11.0 REFERENCES

Convention and Visitors Association of Lane County. 2002. News Release, June 21 and June 28, 2002. Eugene, Oregon.

Eugene Water and Electric Board. Eugene, Oregon. 2001, 2002, 2003. Personal Communications with Corps Personnel.

EPA. May 1986. Quality Criteria for Water. EPA 440/5-86-001.

Hains, John J. April 2000. Water Quality Studies at Cougar Lake Blue River Lake, and the McKenzie River, Oregon. USACE, Waterways Experiment Station.

Lewis, D., Tate, K., Dahlgren, R., and Newell, J. 2002. Turbidity and Total Suspended Solid Concentration Dynamics in Streamflow from California Oak Woodland Watersheds. USDA Forest Service General Technical Report PSW-GTR-184.

Markle, D.F., T.N. Pearsons, and D.T. Bills. 1991. Natural history of *Oregonichthys* (Pisces: Cyprinidae), with a description of a new species from the Umpqua River of Oregon. Copeia 1991:277-293.

Newcombe, C.P., and J.O.T. Jensen. 1996. Channel suspended sediment and fisheries: a synthesis for quantitative assessment of risk and impacts. North American Journal of Fisheries Management 16:693-727.

O'Brien, Patrick S., Dr. Terry M. Sobeck and John Hains. 2003. Developing Reservoir Operational Plans to Manage Erosion and Sedimentation during Construction, Willamette Temperature Control - Cougar Reservoir 2002 – 2003. IN "Proceedings of the Watershed System 2003 Conference, May 2003, Portland, Oreg. US Army Corps of Engineers, Davis, Calif. (Due out as CD, August 2003)

Oregon Department of Fish and Wildlife. Personal communication between ODFW staff and Corps personnel during 2001-2003. Also ODFW Quarterly Reports.

Pearsons, T.N. 1989. Ecology and decline of a rare western minnow: the Oregon chub (*Oregonichthys crameri*). Unpub. M.S. thesis, Oregon State Univ., Corvallis, Oregon.

Stahlberg, Mike. 2002. The water's fine: McKenzie salmon and steelhead fishing is productive as river begins to clear. The Register-Guard. Eugene, Oreg. June 6, 2002.

Stewart, G., J.R. Glassmann, G.E. Grant, S. Lewis, and J. Ninneman. 2002. Evaluation of fine sediment intrusion into salmon spawning gravels as related to Cougar Reservoir sediment releases. Prepared by USDA Forest Service, Pacific Northwest Research Station and Department of Geosciences, Oregon State University, for U.S. Army Corps of Engineers, Portland District, Portland.

The Register-Guard. 2003. Briefly: Outdoor Outlook. April 3, 2003. Eugene, Oreg.

Uhrich, M. 2002. North Santiam River Basin suspended-sediment and turbidity study, in cooperation with: the city of Salem, Oregon and the U.S. Army Corps of Engineers. http://oregon.usgs.gov/santiam/ (as of 24 Jan. 2003). Also, pers. comm. with Corps personnel, 2002-2003. Provisional data.

Wisseman, R. 1996. Benthic invertebrate biomonitoring and bioassessment in western montane streams. Aquatic Biology Associates, Inc., Corvallis, Oregon.